LIQUID DROP JET HEAD, THERMAL ACTUATOR AND INK JET RECORDER

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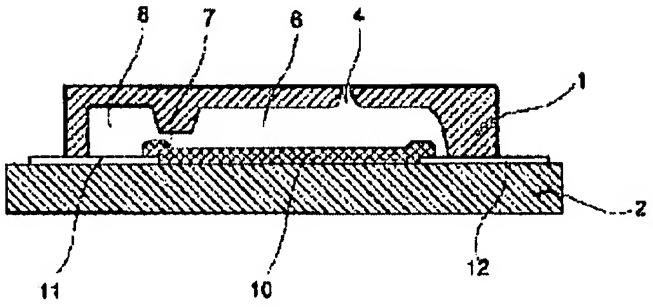
Abstract of **JP2002019108**

PROBLEM TO BE SOLVED: To provide a small liquid drop jet head having high reliability and a thermal actuator suitable therefor capable of improving freedom of selecting a liquid and being readily integrated in the liquid jet head that comprises a nozzle for ejecting ink drops, a liquid chamber communicating with the nozzle and an actuating means for pressurizing ink in the liquid chamber and ejects the ink drops from the nozzle by pressurizing the ink in the liquid chamber by driving the actuator means. SOLUTION: The actuator means made of a conductive material 10 of which the volume is expanded by the thermal expansion caused by energizing is provided on a second substrate 2.



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Back to JP2002019108

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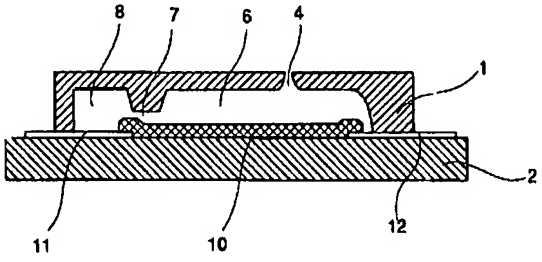
(54)【発明の名称】　液滴吐出ヘッド及びサーマルアクチュエータ並びにインクジェット記録装置

(57)【要約】　（修正有）
【課題】　インク滴を吐出するノズルと、このノズルが連通する液室と、この液室内のインクを加圧するアクチュエータ手段を備えて、アクチュエータ手段を駆動することで液室内のインクを加圧してノズルからインク滴を吐出させる液滴吐出ヘッドにおいて、液体選定の自由度を向上し、信頼性が高い小型、集積化の容易な液滴吐出ヘッド及びこれに適したサーマルアクチュエータの提供。
【解決手段】　第２基板２上に通電により熱膨張して容積が増大する導電性材料１０であるアクチュエータ手段を設けた。



【特許請求の範囲】
【請求項１】　アクチュエータ手段で液室の液体を加圧して液滴を吐出させる液滴吐出ヘッドにおいて、前記アクチュエータ手段は通電により熱膨張して容積が増大する導電性材料であることを特徴とする液滴吐出ヘッド。
【請求項２】　請求項１に記載の液滴吐出ヘッドにおいて、前記導電性材料が熱膨張率の異なる複数の層からなることを特徴とする液滴吐出ヘッド。
【請求項３】　請求項１又は２に記載の液滴吐出ヘッドにおいて、前記導電性材料は、膜厚が１～２０μｍであることを特徴とする液滴吐出ヘッド。
【請求項４】　請求項１ないし３に記載の液滴吐出ヘッドにおいて、前記導電性材料は、線膨張係数が２×１０－Ｅ６／℃～５０×１０－Ｅ６／℃の範囲内の材料であることを特徴とする液滴吐出ヘッド。
【請求項５】　請求項１乃至４のいずれかに記載の液滴吐出ヘッドにおいて、前記導電性材料の液室側表面には耐液性を有する保護膜が成膜されていることを特徴とする液滴吐出ヘッド。
【請求項６】　請求項１乃至５のいずれかに記載の液滴吐出ヘッドにおいて、前記導電性材料の内側に内部構造体を有することを特徴とする液滴吐出ヘッド。
【請求項７】　請求項６に記載の液滴吐出ヘッドにおいて、前記内部構造体が熱硬化性有機樹脂であることを特徴とする液滴吐出ヘッド。
【請求項８】　請求項６に記載の液滴吐出ヘッドにおいて、前記内部構造体が無機材料であることを特徴とする液滴吐出ヘッド。
【請求項９】　請求項６に記載の液滴吐出ヘッドにおいて、前記内部構造体が金属酸化膜を有する金属膜であることを特徴とする液滴吐出ヘッド。
【請求項１０】　請求項６乃至９のいずれかに記載の液滴吐出ヘッドにおいて、前記導電性材料と前記内部構造体との間に空隙を有することを特徴とする液滴吐出ヘッド。
【請求項１１】　請求項６乃至１０のいずれかに記載の液滴吐出ヘッドにおいて、前記内部構造体は、市松状、ライン状又は凹凸状のパターンで設けられていることを特徴とする液滴吐出ヘッド。
【請求項１２】　請求項１乃至１１のいずれかに記載の液滴吐出ヘッドにおいて、前記導電性材料は干渉材層を介して基板に設けられていることを特徴とする液滴吐出ヘッド。
【請求項１３】　請求項１乃至１２のいずれかに記載の液滴吐出ヘッドにおいて、前記導電性材料を設けた基板と前記液室を形成する流路基板とを陽極接合したことをことを特徴とする液滴吐出ヘッド。
【請求項１４】　機械的変位によるアクチュエータ効果を発生するサーマルアクチュエータであって、このサーマルアクチュエータは通電により熱膨張して容積が増大する導電性材料であることを特徴とするサーマルアクチュエータ。
【請求項１５】　インク滴を吐出するインクジェットヘッドを搭載したインクジェット記録装置において、前記インクジェットヘッドが前記請求項１乃至１３のいずれかに記載の液滴吐出ヘッドからなることを特徴とするインクジェット記録装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は液滴吐出ヘッド及びサーマルアクチュエータ並びにインクジェット記録装置に関し、特に熱膨張による変形で液滴を吐出させる液滴吐出ヘッド及び機械的変位によるアクチュエータ効果を発生するサーマルアクチュエータ並びに同液滴吐出ヘッドを備えたインクジェット記録装置に関する。
【０００２】
【従来の技術】一般に、プリンタ、ファクシミリ、複写装置、プロッタ等の画像記録装置（画像形成装置）として用いるインクジェット記録装置において使用するマイクロアクチュエータを含む液滴吐出ヘッドであるインクジェットヘッドは、インク滴を吐出するノズルと、このノズルが連通する液室（加圧室、圧力室、加圧液室、インク流路、吐出室等とも称される。）と、この液室内のインクを加圧する圧力発生手段（アクチュエータ手段）とを備えて、アクチュエータ手段を駆動することで液室内インクを加圧してノズルからインク滴を吐出させる。
【０００３】従来のインクジェットヘッドは、アクチュエータ手段の種類という点から、圧電素子を用いて液室の壁面を形成する振動板を変形変位させることでインク滴を吐出させるピエゾ型のもの、液室内に配設した発熱抵抗体を用いてインクの膜沸騰でバブルを発生させてインク滴を吐出させるバブル型のもの、液室の壁面を形成する振動板（又はこれと一体の電極）と対向電極を用いて静電力で振動板を変形変位させることでインク滴を吐出させる静電型のものなどに大別される。
【０００４】
【発明が解決しようとする課題】上述したようなインクジェットヘッドの内、ピエゾ型にあっては、圧電素子がインクに直接接触せず、圧電素子の発熱も無視できるため、使用するインク種類の制約がないという利点がある反面、圧電素子の高熱処理（ＰＺＴ焼成）、積層型圧電素子を用いる場合には分割化、個々の圧電素子の位置合わせ等の機械的、熱的な技術課題が大きく、煩雑な工程と装置によってコストが高くなる。
【０００５】また、バブル型にあっては、半導体技術の応用によってヒータを非常に小さくできることから、ヘッドの高集積化、小型化が容易であるという利点を有する反面、バブルを発生させるためにヒータ表面温度が４００～４５０℃と高くなり、インクに極端な高熱を与えることからインク組成が変化し、ヒータのインク接触部

分でのコゲーションが発生する。そのため、インク染料の選択が重要になり、顔料インクを使用することが難しく、カラー画像の高画質化に限界が生じ、またコゲーションによるヒータの劣化でバブル発生が不良になったり、高熱のためにヒータ保護膜が劣化してクラックによるヒータ断線などの不良が発生し易い。

【０００６】さらに、静電型にあっては、ピエゾ型と同様に微細加工のプロセスが困難であり、材料選択性が少なく、プロセス工程が長く、コスト高になる。

【０００７】本発明は上記の点に鑑みてなされたものであり、液体選定の自由度を向上し、コゲーションの問題もなく、信頼性が高い小型、集積化の容易な液滴吐出ヘッド及びこれに適したサーマルアクチュエータを提供することを目的とする。

【０００８】

【課題を解決するための手段】上記の課題を解決するため、本発明に係る液滴吐出ヘッドは、アクチュエータ手段が通電により熱膨張して容積が増大する導電性材料である構成としたものである。

【０００９】ここで、導電性材料が熱膨張率の異なる複数の層からなる構成とすることができる。また、導電性材料は、膜厚が１～２０μｍであることが好ましい。さらに、導電性材料は、線膨張係数が２×１０－Ｅ６／℃～５０×１０－Ｅ６／℃の範囲内の材料であることが好ましい。導電性材料の液室側表面には耐液性を有する保護膜が成膜されていることが好ましい。

【００１０】さらに、導電性材料の内側に内部構造体を有することが好ましい。この場合、内部構造体としては、熱硬化性有機樹脂、無機材料或いは金属酸化膜を有する金属膜であることが好ましい。また、導電性材料と内部構造体との間に空隙を有することが好ましい。この内部構造体は、市松状、ライン状又は凹凸状のパターンで設けることができる。

【００１１】さらにまた、導電性材料は干渉材層を介して基板に設けられることができる。また、導電性材料を設けた基板と液室を形成する流路基板とを陽極接合することができる。

【００１２】本発明に係るサーマルアクチュエータは、通電により熱膨張して容積が増大する導電性材料である構成としたものである。

【００１３】本発明に係るインクジェット記録装置は、インク滴を吐出するインクジェットヘッドが本発明に係る液滴吐出ヘッドからなる構成としたものである。

【００１４】

【発明の実施の形態】以下、本発明の実施の形態を添付図面を参照して説明する。図１は本発明の第１実施形態に係る液滴吐出ヘッドであるインクジェットヘッドの要部模式的断面図、図２は同インクジェットヘッドの第２基板の斜視説明図である。

【００１５】このインクジェットヘッドは、流路基板である第１基板１と、第２基板２とを接合してなり、インク滴を吐出するノズル４、ノズル４が連通する液室６、液室６に流体抵抗部７を介してインクを供給する共通インク室８を形成している。

【００１６】第１基板１には、ノズル４となる穴部、液室６、流体抵抗部７及び共通インク室８を形成する凹部を形成している。この第１基板１としては、シリコン基板やガラス基板を用いて、穴部や凹部をエッチングなどによっても形成することができるが、やガラス基板などを用いることができ、ここではガラス基板に対するサンドブラスト工法によってノズル４となる穴部、液室６、流体抵抗部７及び共通インク室８を形成する凹部を形成している。

【００１７】第２基板２には、通電により熱膨張して容積が増大する導電性材料１０からなるアクチュエータ手段を設け、この導電性材料１０には共通電極１１及び個別駆動電極１２を接続している。この第２基板２としては、シリコン基板（シリコンウエハ）、ガラス基板、セラミックス基板などを用いることができるが、ここではガラス基板を用いている。

【００１８】導電性材料１０としては、通電による熱膨張により容積が増大する単層又は複層構成のものを用いる。例えば金属材料として、Ａｌ，Ni-Co、Ni-Mn、Cu-Ni、Cu-Zn、ジュラルミン、Cu-Sn、Ni等を用いることができる。

【００１９】この導電性材料１０の膜厚は１μｍ～２０μｍの範囲内とすることが好ましく、より好ましくは５μｍ～１０μｍの範囲内である。すなわち、例えばインク滴量を２ｐｌ～３５ｐｌの範囲で制御するためには導電性材料の膜厚と縦×横のサイズにより概略インク容積が決定されるが、導電性材料１０の膜厚が１μｍ未満では、薄膜であり導電性材料１０のバルク効果が少なく、昇温に対して体積膨張が律則でないため、厚さの変位量が小さく、２ｐｌのインク滴量を確保することができない。また、膜厚が２０μｍを越えると、膜成長時の内部応力が大きくなり、導電性材料全体が剥離したり、変形が発生するとともに、通電電流が大きくなり、このヘッドを駆動するためのスイッチングトランジスタのゲート幅が広くなって実用的でない。特に、導電性材料１０の膜厚を５μｍ～１０μｍの範囲内にすることで、低コストのリレースイッチＩＣで駆動することが可能になる。

【００２０】また、導電性材料１０の線膨張係数は２×１０-Ｅ６／℃～５０×１０-Ｅ６／℃の範囲内とすることが好ましい。導電性材料１０の線膨張係数が２×１０-Ｅ６／℃未満では、通電による熱膨張が十分でなく、所望のインク滴吐出が得られないことがあり、線膨張係数が５０×１０-Ｅ６／℃を超える（例えばサーミスタ）場合には、複合酸化物の非晶質部分が多くなり、通電による温度上昇によって再結晶が生じ易く、信頼性の確保が困難になる。

【００２１】以上のように構成したインクジェットヘッドにおいては、共通電極１１と個別駆動電極１２との間に駆動波形を印加して導電性材料１０に通電することにより、導電性材料１０が熱膨張して容積が増大するので、液室６内の内容積（体積）／圧力が変化して、ノズル４からインク滴が吐出される。この場合、導電性材料１０に接触しているインク自体の接触部分の温度上昇もインク加圧に対して相乗効果がある。

【００２２】例えば、導電性材料１０として、１０μｍ厚さのＣｕ（銅）（線膨張係数１６．７×１０E-6／℃）を用いると、通電温度（約２００℃）上昇による材料の熱膨張容積増大は、１００dpi相当で幅１６０μｍ×縦３０００μｍでは約１６plの容積インク液を加圧することで、微小インク滴を各チャンネルノズル４から飛翔させることが可能である。

【００２３】この場合、流体抵抗部７の流体抵抗や駆動波形の形状を設定して温度上昇の時定数の適正化し、また、導電性材料１０の面積と厚さ、温度上昇の最適化を図ることが好ましい。

【００２４】このように、通電により熱膨張して容積が増大する導電性材料１０であるアクチュエータ手段を備えることにより、導電性材料の通電温度（約２００℃）上昇による材料の熱膨張容積増大と導電性材料の表面近傍のインク熱膨張で液室内インクが加圧されて、微小インク滴が吐出される。この場合、インクダメージが少なく、インク材料が有機無機材料に限られないので、高画質記録を行うための色材選択性が広くなり、また、サテライト滴も小さく画素径の歪が小さいので、高画質記録を行うことができ、さらにその作製工法は通常のＩＣ技術を適用できて、工程が短く、安価に製造することができる。

【００２５】ここで、特に、第１基板１としてサンドブラスト工法で流路（液室６、流体抵抗部７、共通インク室８など）をガラス基板に形成したものを用い、第２基板２としてガラス基板にＩＣ工法で導電性材料１０を形成したものを用いることにより、その熱膨張率が略一致しており、ガラス基板には可動イオンを含むので、陽極接合が容易になり、一層の低コスト化を図れる。また、接着剤等を用いない接合を行うことで、隣接チャンネル間への接着剤のはみ出しがなく、各チャンネルに容積バラツキがない。さらにインクの濡れ性が均一であり、インク液室に内部残留気泡がなくインク飛翔が各チャンネル共均一になる。

【００２６】そこで、このサンドブラスト工法による流路形成について図３を参照して簡単に説明する。先ず、同図（ａ）に示すような第１基板１となるガラス基板２１にレジストを塗布或いはラミネートし、露光、現像を行って、同図（ｂ）に示すようにノズル４、液室６、流体抵抗部７及び共通インク室８の流路パターンに応じた開口２３を有するサンドブラスト用のレジストパターンによるマスク２２を形成する。

【００２７】次いで、同図（ｃ）に示すように、砥粒径の大きな砥粒を用いたサンドブラスト加工を行って凹部２４を形成した後、同図（ｄ）に示すように砥粒径の小さな砥粒を用いたサンドブラスト加工を行って凹部２４の壁面を仕上げた凹部２５を形成する。

【００２８】サンドブラスト工法による精密切削加工を行う場合、砥粒径が３μｍ未満の砥粒を用いても加工できるが、このときの切削レイト（切削速度）は非常に小さく（０．５μｍ／min程度）なり、砥粒径が１５μｍを越える砥粒を用いた場合にはチッピングが大きくなるので、高速精密切削には不向きである。一方、使用する砥粒の粒径と切削時のチッピングのサイズは略相関関係にある。そこで、最初に大きな粒径（例えば１５μｍ）の砥粒を用いて目的深さの８０％程度を切削し、その後、小さな粒径（例えば３μｍ）の砥粒を用いて目的深さまで切削することで、切削面のチッピングの大きさを小さくしつつ、切削速度（タクトタイム）を速くすることができる。

【００２９】その後、同図（ｅ）に示すように、サンドブラストによるチッピングやヘアークラックをポリシラザンでスピンコートし、これを１５０～４５０℃に加熱分解酸化することで、SiO_2の表面コート層２７を形成して、壁面を平滑化した液室６となる凹部２６を形成する。ここで、SiO_2の表面コート層２７の厚さは５００～５０００Åであり、好ましくは１０００～２０００Åである。ポリシラザンは加熱分解酸化することにより、純粋なアモルファスSiO_2の膜になり、インク信頼性（接液耐性）が向上する。

【００３０】また、第１基板１に液室６等をサンドブラスト工法で形成する場合、ポリシラザンを液室壁面等の表面コート層として用いることで、第２基板２との陽極接合が容易になり、安価に直接固体接合が可能になる。すなわち、第１基板１の全面にポリシラザンの膜を形成した場合、ポリシラザンの処理膜は表面平滑性が良く、陽極接合時の電圧印加をしたとき、不純物が少ないことから高抵抗であり、電荷が集中することになる。これにより、第１基板１に含まれる可動イオンが接合界面に電荷集中と共に移動し、イオン反応で結合（接合）する。このとき、高抵抗によるイオン電流の低減が生じない範囲の膜厚、好ましくは１０００～２０００Åにする。これにより、陽極接合が容易になる。

【００３１】なお、サンドブラスト面の平滑化は、例えば、フッ酸５～３０ｗｔ％を含む、鉱産として硫酸、リン酸、硝酸、酢酸の単体又は二以上の混酸による化学的エッチングで行うこともでき、これにより、チッピングは１μｍ以下になり、サンドブラスト切削によるヘアークラックも除去され、ガラス状の表面を確保することができる。また、例えばガラス基板を３００℃加熱して、炭酸ガスレーザーでスキャンアニールを行うことによっ

ても、切削部分の白濁はアニール融解し、チッピングやヘアークラックはメルトされて、半透明のガラス状になる。

【００３２】次に、本発明の第２実施形態について図４乃至図６を参照して説明する。なお、図４は同実施形態に係るインクジェットヘッドの要部模式的断面図、図５は同ヘッドの要部平面説明図、図６は図５のＡ－Ａ線に沿う要部断面説明図である。この実施形態は、上記第１実施形態がノズル４を導電性材料１０に対して対向する位置に配置したサイドシュータ方式であるのに対し、ノズル４を導電性材料１０に対して略平行に配置したエッジシュータ方式である。

【００３３】このインクジェットヘッドも、流路基板である第１基板１と、第２基板２とを接合してなり、インク滴を吐出するノズル４、ノズル４がノズル連通路５を介して連通する液室６、液室６に流体抵抗部７を介してインクを供給する共通インク室８を形成している。そして、この第１基板１と導電性材料１０を設けた第２基板２とを陽極接合している。また、共通電極１２の一部は図５に示すように各導電性材料１０、１０間、すなわち液室間の隔壁１３に対応する部分に延設した延設部１２ａを一体形成している。

【００３４】ここで、このインクジェットヘッドを例にして第１基板１と第２基板２との陽極接合について図７をも参照して説明する。同図に示すように、第１基板１を第２基板２上に重ね合わせた状態で、第１基板１上にメタル電極２８を配設し、電極１２とメタル電極２８との間に３００～６００Ｖ、温度２５０～４００℃、時間２～１０分間の条件で、ＤＣ電圧を印加することによって、第１ガラス基板１であるガラス内でNa_2SiO3がNa^+とSiO_3^{2-}に分離し、電極１２表面でイオン結合（Ｓｉ－Ｏ－Ｎｉ、Ｓｉ－Ｏ－Ｃｒ）が生じるので、第1ガラス基板１と第２ガラス基板２とが接合される。

【００３５】次に、本発明の第３実施形態について図８を参照して説明する。なお、同図は同実施形態の第２基板側の要部拡大説明図である。この実施形態は、第２基板２上に内部構造体３１を形成し、この内部構造体３２表面を含めて導電性材料１０を設けることにより、導電性材料１０の内部に内部構造体３１を設けたものである。内部構造体３１としては、熱硬化性有機樹脂材料、例えばポリイミド、液晶ポリマー、ベークライト、ポリアミド、ノボラック系樹脂などを用いている。

【００３６】このように、導電性材料１０の内部に熱硬化性有機樹脂材料の内部構造体３１を設けて、導電性材料１０の表面積と容積を増大させることにより、例えば、熱硬化有機樹脂材料としてのポリイミド（線膨張係数、３３×１０Ｅ-6／℃）５μｍの通電温度（約２００℃）上昇による材料の熱膨張容積増大によって約２０plのインクを加圧することが可能である。

【００３７】この第３実施形態では、第１実施形態よりも膨張容積が増大するので、通電による温度上昇の範囲が広くなり、インク滴の変調も可能であり、インクダメージが少なく、その高画質色材選択性が大きく、またサテライト滴も小さく画素径の歪が小さくなり、より高画質記録を行うことができる。

【００３８】次に、本発明の第４実施形態について図９及び図１０を参照して説明する。なお、図９は同実施形態の第２基板側の要部拡大説明図、図１０は図９の要部拡大説明図である。この実施形態も、上記第３実施形態と同様に、第２基板２上に熱硬化性有機樹脂材料からなる内部構造体３１を形成し、この内部構造体３１表面を含めて導電性材料１０を設けることで、導電性材料１０の内部に内部構造体３１を設け、更に導電性材料１０と内部構造体３１との間に空隙３２を形成したものである。

【００３９】例えば、熱硬化性有機樹脂材料は熱縮重合反応により硬化が進むが、ポリイミド樹脂の場合は、熱縮重合反応を伴いH_2O、CO_2を発生させ、材料固体は約４０ｗｔ％減少する。ポリイミド樹脂をホトリソやドライエッチング等で適正形状にパターン化し、プリベーク温度２５０℃処理後に導電性材料１０の蒸着とパターン化を行って、３５０℃で最終熱硬化処理を実施する。このとき、適性制御することにより、微量の残留ガスが発生して、導電性材料１０とポリイミド（内部構造体３１）との間が一部剥離して、空隙３２が形成される。

【００４０】この場合、図１０に示すように、内部構造体３１の壁面３１ａを荒らすなどしておくことで、導電性材料１０に対するアンカー効果が発揮されて壁面３１ａ部分での導電性材料１０の剥離が生じ難くなり、一方、内部構造体３１の上面３１ｂを平面平滑化しておくことで導電性材料１０の剥離が生じ易くなって、容易に目的とする部分で意図的に導電性材料１０を内部構造体３１から剥離させることができる。なお、導電性材料１０の第２基板２表面との固定部１０ａは例えばプラズマ処理で強固な密着性を得られる。

【００４１】このように、導電性材料１０の内部に熱硬化性有機樹脂材料からなる内部構造体３１を設け、導電性材料１０の内部に熱硬化性有機樹脂材料からなる内部構造体３１との間にガスが封入された空隙３２を有することにより、通電による温度上昇によって導電性材料１０の熱膨張に有機樹脂材料（内部構造体３１）の熱膨張が相乗され、これに空隙３２内の微少ガスの熱膨張が加わるので、インク液の昇温を含み、インクを加圧することで、一層、効率良く、微小インク滴を吐出させることができ、また、電流制御による材料の熱膨張容積の制御が可能になり、ドット系変調による階調記録ができ、さらにインクダメージが少なく、高画質色材の選択性が広くなり、サテライト滴も小さく画素径の歪みが小さいので、高画質記録を行えるようになる。

【００４２】次に、本発明の第５実施形態について図１

１及び図１２を参照して説明する。なお、図１１は同実施形態の第２基板側の要部拡大説明図、図１３は図１２の要部拡大説明図である。この実施形態は、第２基板２上に無機材料からなる内部構造体３３を形成し、この内部構造体３３表面を含めて導電性材料１０を設けることにより、導電性材料１０の内部に内部構造体３３を設けたものである。

【００４３】この内部構造体３３としては、熱ZrO_2、SiO_2、TiO_2などのファインセラミックスを用いている。このファインセラミックスは真空度が悪い低真空でのスパッタ膜とすることで、内部に空隙３４を有する蒸着膜となる。

【００４４】この内部構造体３３の空隙３４によって導電性材料１０が部分的に内部構造体３３表面から剥離して、内部構造体３３と導電性材料１０との間に空隙３５が形成されて、この空隙３５内にガスが充満した状態になる。

【００４５】このように、導電性材料１０の内部にセラミックスからなる内部構造体３３を設け、導電性材料１０の内部にセラミックスからなる内部構造体３３との間にガスが封入された空隙３５を有することにより、通電による温度上昇によって導電性材料１０の熱膨張にセラミックス（内部構造体３３）の熱膨張が相乗され、これに空隙３５内の微少ガスの熱膨張が加わるので、インク液の昇温を含み、インクを加圧することで、一層、効率良く、微小インク滴を吐出させることができる。また、熱膨張変形による内部応力の緩和と熱伝導性を考慮し、廃熱を促進させ、高速駆動が可能となる。

【００４６】次に、本発明の第６実施形態について図１３及び図１４を参照して説明する。なお、図１３は同実施形態の第２基板側の要部拡大説明図、図１４は図１３の要部拡大説明図である。この実施形態は、第２基板２上に金属酸化膜を有する金属膜からなる内部構造体３６を形成し、この内部構造体３３表面を含めて導電性材料１０を設けることにより、導電性材料１０の内部に内部構造体３６を設けたものである。

【００４７】内部構造体３６としては、金属酸化膜を具備する金属膜、例えばＡｌ、Ｔｉなどの膜を用いている。この金属、例えばＡｌ、Ｔｉなどの表面は陽極酸化することで、内部に気孔３７を有する多孔質の金属酸化層３８が形成される。

【００４８】そこで、この内部構造体３６の気孔３７を例えば$\gamma-Al_2O_3$による厚さ約１μｍの封孔膜３９を形成して封止し、この上に導電性材料１０を形成することにより、内部構造体３５と導電性材料１０との間に気孔３７からなる空隙が形成されて、この気孔３７内にガスが充満した状態になる。

【００４９】このように、導電性材料１０の内部に金属酸化膜３８を有する金属膜からなる内部構造体３６を設け、導電性材料１０の内部に金属膜（内部構造体３６）との間にガスが封入された空隙である気孔３７を有することにより、通電による温度上昇によって導電性材料１０の熱膨張に金属膜（内部構造体３６）の熱膨張が相乗され、これに気孔３７内の微少ガスの熱膨張が加わるので、インク液の昇温を含み、インクを加圧することで、一層、効率良く、微小インク滴を吐出させることができる。また、熱膨張変形による内部応力の緩和と熱伝導性を考慮し、廃熱を促進させ、高速駆動が可能となる。

【００５０】次に、本発明の第７実施形態について図１５を参照して説明する。なお、同図は同実施形態の第２基板側の要部拡大説明図である。この実施形態は、第２基板２上に熱硬化性有機樹脂からなる内部構造体３１を形成し、この内部構造体３１表面を含めて複層構造（ここでは、２層構造）の導電性材料１０を設けている。この複層構造の導電性材料１０は、例えば、下部層４１として白金（Ｐｔ）（線熱膨張係数８．７×１０EE-6／℃）を２μｍ厚さで成膜し、この下部層４１表面に上部層４２としてニクロム（Ni-Cr）（線熱膨張係数数６×１０E-6／℃）を５μｍで成膜したものである。この導電性材料１０と内部構造体３１との間には微少ガスが含まれた空隙３２が形成されている。

【００５１】このように導電性材料１０を複層構造とすることにより、通電による温度上昇によって、導電性材料１０は下部層４１と上部層４２との熱膨張率の差により、上部層４２側にに凸状変形するバイメタル効果が発揮されるので、更に効率的に微小インク滴を吐出させることができる。なお、内部構造体３１としては、上記各実施形態の内部構造体３３、３６などを用いることもできる。

【００５２】次に、本発明の第８実施形態について図１６を参照して説明する。なお、同図は同実施形態の第２基板側の要部拡大説明図である。この実施形態は、第２基板２上に内部構造体３１を形成し、この内部構造体３１表面を含めて複層構造（ここでは、２層構造）の導電性材料１０を設け、更に導電性材料１０表面（上部層４２表面）に耐インク性を有する保護層４３を形成したものである。

【００５３】ここで、保護層４３としては、ポリイミド膜、アラミド膜などの有機膜を用いている。このように複層構造の導電性材料１０を用いてバイメタル効果を生ぜしめる場合には、無機材料の保護膜ではバイメタル材料の変位量が大きくクラックを発生することになるので、有機膜の方が好ましい。

【００５４】これにより、　　導電性材料１０をインクから保護することができる。すなわち、インクには有機イオン染料、イオンを含む顔料、さらに分散剤や界面活性剤が含まれるので、耐インク性のない導電性材料が表面になる場合には、耐インク性を有する保護層４３を形成することで、導電性材料１０の浸食を防止でき、長期信頼性を確保できる。

【００５５】次に、本発明の第９実施形態について図１７を参照して説明する。なお、同図は同実施形態の第２基板側の要部拡大説明図である。この実施形態は、第２基板２上に設ける導電性材料１０の耐インク性のある無機材料からなる保護膜４４を形成したものである。この保護膜４４としては、無機酸化膜、例えば無機酸化物（SiO_2、Si_3N_4、ＳｉＯＮなど）、チッ化膜（ＴｉＮ、ＢＮ、ＡｌＮなど）、カーバイド膜（ＳｉＣ、ＢＣ膜等）である。

【００５６】導電性材料１０として、線熱膨張率が５０×１０-Ｅ６／℃を越える材料やサーミスタ材料、熱膨張率の大きなＭｇやＩｎ、Ａｌ、Ｋ、Ｃｕ、Ｎａ、Ｐｂ、Ｌｉなどを含む合金を用いる場合、耐インクが悪く、特に顔料分散剤や界面活性剤の濃度が高い（２～３ｗｔ％）場合には、導電性材料１０が溶出するおそれがある。そこで、無機材料からなる保護膜４４を導電性材料１０表面に成膜することで、導電性材料１０をインクから保護することができ、導電性材料１０の浸食を防止して長期信頼性を確保できる。

【００５７】次に、本発明の第１０実施形態について図１８を参照して説明する。なお、同図は同実施形態の第２基板側の要部拡大説明図である。この実施形態は、第２基板２上に干渉材層４５を介して内部構造体３１及び導電性材料１０を形成したものである。干渉材層４５としては、特にグレーズ層として１０～５０μｍのフリットガラスを用いている。グレーズ層に代えて、１～１０μｍのSiO_2膜、ＳｉＯＮのアモルファス膜層などを設けてもよい。

【００５８】このように干渉材層４５を設けることにより、熱膨張変形による内部応力が緩和され、熱伝導性による廃熱が促進されて高速駆動が可能になるとともに、導電性材料と基板との密着性が向上して剥離を防止でき、信頼性が向上する。

【００５９】次に、導電性材料１０の内部構造体３１（内部構造体３３、３６も同様である。）の配置パターンの異なる例について図１９乃至図２４を参照して説明する。なお、図１９は同配置パターンの第１例を説明する平面説明図、図２０は同じく第１例を説明する断面説明図、図２１は同配置パターンの第２例を説明する平面説明図、図２２は同じく第２例を説明する断面説明図、図２３は同配置パターンの第３例を説明する平面説明図、図２４は同じく第３例を説明する断面説明図である。

【００６０】すなわち、第１例は、内部構造体３１を第２基板２上にライン状（内部構造体３１間にスリットが形成される状態）に配置した例であり、第２例は、内部構造体３１を第２基板２上に市松状に配置した例であり、第３例は、内部構造体３１を第２基板２上に凹凸状に配置した例である。

【００６１】このように内部構造体３１の配置パターンを選択することによって、通電による温度上昇による導電性材料１０の熱膨張による容積増大のコントロールと内部構造体３１からの部分剥離の制御を行うことができる。これにより、導電性材料１０の膨張変位量の容積制御と各チャンネル内の基板２との接着個所、面積を決定することができ、インク滴の定量制御になり、信頼性が向上する。なお、パターンの形状は、部分剥離と固定面積を適正化できれば、その範囲で自由である。

【００６２】ここで、熱硬化性有機樹脂の内部構造体３１を用いる場合、ポリイミド系樹脂は光学感応性の材料があり、ＩＣホトリソで目的形状にパターン化することが容易にできる。また、光学感応性のない材料を用いる場合には、同様にＩＣホトリソによるドライエッチ工法を加味することによって容易にパターン化することができる。

【００６３】また、無機（上述したファインセラミックスなど）材料の内部構造体３３を用いる場合には、セラミックスの低真空スパッタ蒸着法で空隙３４を持つ成膜であり、高真空では緻密なスッパタ膜ができる。さらに、金属酸化膜を具備する金属膜の内部構造体３６の製法は、Ａｌ，Ｔｉのように陽極酸化で、空隙の孔サイズと孔深さが制御できるものが好ましく、これらの材料は、封孔が可能であり、その膜厚も処理温度と時間さらに化学薬品で決めることができる。

【００６４】次に、本発明に係るインクジェット記録装置について図２５及び図２６を参照して簡単に説明する。なお、図２５は同記録装置の機構部の概略斜視説明図、図２６は同機構部の側面説明図である。

【００６５】このインクジェット記録装置は、記録装置本体６１の内部に主走査方向に移動可能なキャリッジ、キャリッジに搭載した本発明に係る液滴吐出ヘッドであるインクジェットヘッドからなる記録ヘッド、記録ヘッドへのインクを供給するインクカートリッジ等で構成される印字機構部６２等を収納し、装置本体６１の下方部には前方側から多数枚の用紙６３を積載可能な給紙カセット（或いは給紙トレイでもよい。）６４を抜き差し自在に装着することができ、また、用紙６３を手差しで給紙するための手差しトレイ６５を開倒することができ、給紙カセット６４或いは手差しトレイ６５から給送される用紙６３を取り込み、印字機構部６２によって所要の画像を記録した後、後面側に装着された排紙トレイ６６に排紙する。

【００６６】印字機構部６２は、図示しない左右の側板に横架したガイド部材である主ガイドロッド７１と従ガイドロッド７２とでキャリッジ７３を主走査方向に摺動自在に保持し、このキャリッジ７３にはイエロー（Ｙ）、シアン（Ｃ）、マゼンタ（Ｍ）、ブラック（Ｂｋ）の各色のインク滴を吐出する本発明に係る液滴吐出ヘッドであるインクジェットヘッドからなるヘッド７４をインク滴吐出方向を下方に向けて装着し、キャリッジ

７３の上側にはヘッド７４に各色のインクを供給するための各インクタンク（インクカートリッジ）７５を交換可能に装着している。このインクカートリッジ７５から前記インク供給穴を介してインクをヘッド７４内に供給する。

【００６７】ここで、キャリッジ７３は後方側（用紙搬送方向下流側）を主ガイドロッド７１に摺動自在に嵌装し、前方側（用紙搬送方向上流側）を従ガイドロッド７２に摺動自在に載置している。そして、このキャリッジ７３を主走査方向に移動走査するため、主走査モータ７７で回転駆動される駆動プーリ７８と従動プーリ７９との間にタイミングベルト８０を張装し、このタイミングベルト８０をキャリッジ８３に固定している。また、記録ヘッドとしてここでは各色のヘッド７４を用いているが、各色のインク滴を吐出するノズルを有する１個のヘッドでもよい。

【００６８】一方、給紙カセット６４にセットした用紙６３をヘッド７４の下方側に搬送するために、給紙カセット６４から用紙６３を分離給装する給紙ローラ８１及びフリクションパッド８２と、用紙６３を案内するガイド部材８３と、給紙された用紙６３を反転させて搬送する搬送ローラ８４と、この搬送ローラ８４の周面に押し付けられる搬送コロ８５及び搬送ローラ８４からの用紙６３の送り出し角度を規定する先端コロ８６とを設けている。搬送ローラ８４は副走査モータ８７によってギヤ列を介して回転駆動される。

【００６９】そして、キャリッジ７３の主走査方向の移動範囲に対応して搬送ローラ８４から送り出された用紙６３を記録ヘッド７４の下方側で案内する用紙ガイド部材である印写受け部材８９を設けている。この印写受け部材８９の用紙搬送方向下流側には、用紙６３を排紙方向へ送り出すために回転駆動される搬送コロ９１、拍車９２を設け、さらに用紙６３を排紙トレイ６６に送り出す排紙ローラ９３及び拍車９４と、排紙経路を形成するガイド部材９５，９６とを配設している。

【００７０】また、キャリッジ７３の移動方向右端側にはヘッド７４の信頼性を維持、回復するための信頼性維持回復機構（以下「サブシステム」という。）９７を配置している。キャリッジ７３は印字待機中にはこのサブシステム９７側に移動されてキャッピング手段などでヘッド７４をキャッピングされる。

【００７１】なお、上記各実施形態においては、本発明に係る液滴吐出ヘッド及びサーマルアクチュエータをインクジェットヘッドに適用した例で説明したが、これに限るものではなく、例えば、インク以外の液滴、例えば、パターニング用の液体レジストを吐出する液滴吐出ヘッドにも適用でき、或いはサーマルアクチュエータとしてはマイクロモータ、マイクロポンプのアクチュエータ部などにも適用することができる。

【００７２】

【発明の効果】以上説明したように、本発明に係る液滴吐出ヘッドによれば、アクチュエータ手段が通電により熱膨張して容積が増大する導電性材料である構成としたので、液によるダメージが少なく、液材料（色材）の選定の自由度が向上し、また、信頼性が高く小型、集積化が容易になり、更に低コスト化を図れる。

【００７３】ここで、導電性材料が熱膨張率の異なる複数の層からなる構成とすることで、導電性材料の容積変化が大きくなって液滴吐出効率の向上を図ることができる。また、導電性材料は、膜厚が１～２０μｍの範囲内とすることで、所望の滴量を確保できるとともに低電流駆動が可能になる。さらに、導電性材料は、線膨張係数が２×１０－Ｅ６／℃～５０×１０－Ｅ６／℃の範囲内の材料であることで、所望の滴量を確保できるとともに低電流駆動が可能になる。また、導電性材料の液室側表面には耐液性を有する保護膜を成膜することで、長期信頼性を確保できる。

【００７４】さらに、導電性材料の内側に内部構造体を有することにより、導電性材料の熱膨張容積増大と内部構造体の熱膨張容積増大が相乗して、より効率的な滴吐出が可能になる。

【００７５】この場合、内部構造体として、熱硬化性有機樹脂を用いることで電流制御による熱膨張容積制御が可能になってドット径変調が容易になる。また、無機材料或いは金属酸化膜を有する金属膜を用いることで、熱伝導性が向上して、蓄熱が低減され、高速駆動化を図れる。また、導電性材料と内部構造体との間に空隙を有することにより、空隙内のガスの膨張も相乗されて、一層効率的に液滴吐出を行うことができる。

【００７６】この内部構造体は、市松状、ライン状又は凹凸状のパターンで設けることによって、インク滴の定量制御が可能になってドット径制御ができるようになり、信頼性も向上する。

【００７７】さらにまた、導電性材料は干渉材層を介して基板に設けられることによって、導電性材料と基板との密着性が向上し、信頼性が向上する。また、導電性材料を設けた基板と液室を形成する流路基板とを陽極接合することによって、低コスト化を図れる。

【００７８】本発明に係るサーマルアクチュエータによれば、通電により熱膨張して容積が増大する導電性材料である構成としたので、信頼性が高く小型、集積化が容易になり、更に低コスト化を図れる。

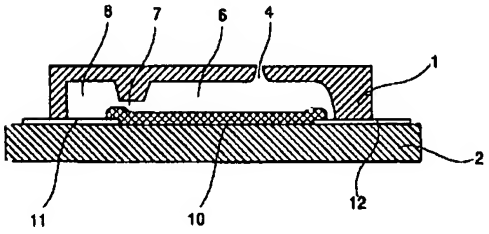
【００７９】本発明に係るインクジェット記録装置によれば、インク滴を吐出するインクジェットヘッドが本発明に係る液滴吐出ヘッドからなるので、液材料（色材）の選定の自由度が向上して高画質化を図れるとともに、低コスト化を図れる。

【図面の簡単な説明】

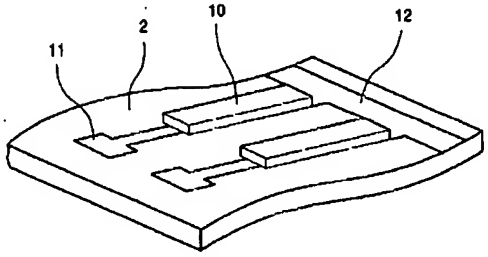
【図１】本発明の第１実施形態に係るインクジェットヘッドの要部模式的断面図

【図２】同ヘッドの第２基板の斜視説明図
【図３】同ヘッドの第１基板の製造工程の一例を説明する説明図
【図４】本発明の第２実施形態に係るインクジェットヘッドの要部模式的断面図
【図５】同ヘッドの第２基板の要部平面説明図
【図６】図５のＡ－Ａ線に沿う要部断面説明図
【図７】同ヘッドにおける陽極接合の説明に供する説明図
【図８】本発明の第３実施形態の第２基板側の要部拡大説明図
【図９】本発明の第４実施形態の第２基板側の要部拡大説明図
【図１０】図９の要部拡大説明図
【図１１】本発明の第５実施形態の第２基板側の要部拡大説明図
【図１２】図１１の要部拡大説明図
【図１３】本発明の第６実施形態の第２基板側の要部拡大説明図
【図１４】図１３の要部拡大説明図
【図１５】本発明の第７実施形態の第２基板側の要部拡大説明図
【図１６】本発明の第８実施形態の第２基板側の要部拡大説明図
【図１７】本発明の第９実施形態の第２基板側の要部拡大説明図
【図１８】本発明の第１０実施形態の第２基板側の要部拡大説明図
【図１９】本発明における内部構造体の配置パターンの第１例を説明する平面説明図
【図２０】同じく第１例を説明する断面説明図
【図２１】本発明における内部構造体の配置パターンの第２例を説明する平面説明図
【図２２】同じく第２例を説明する断面説明図
【図２３】本発明における内部構造体の配置パターンの第３例を説明する平面説明図
【図２４】同じく第３例を説明する断面説明図
【図２５】本発明に係るインクジェット記録装置の一例を示す機構部の概略斜視説明図
【図２６】同機構部の側面説明図
【符号の説明】
1…第１基板、2…第２基板、4…ノズル、6…液室、7…流体抵抗部、8…共通インク室、１０…導電性材料、１１…個別駆動電極、１２…共通電極、３１，３３，３６…内部構造体、３２，３４…空隙、３７…気孔、４１…下部層、４２…上部層、４３，４４…保護膜、７４…ヘッド。

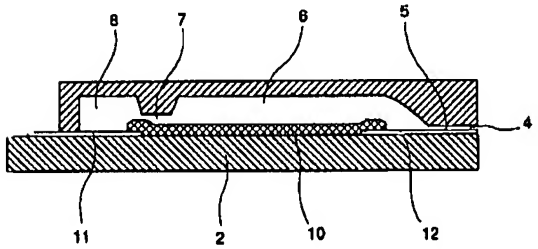
【図１】



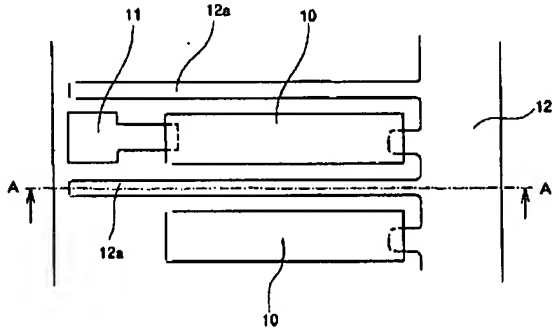
【図２】



【図４】



【図５】



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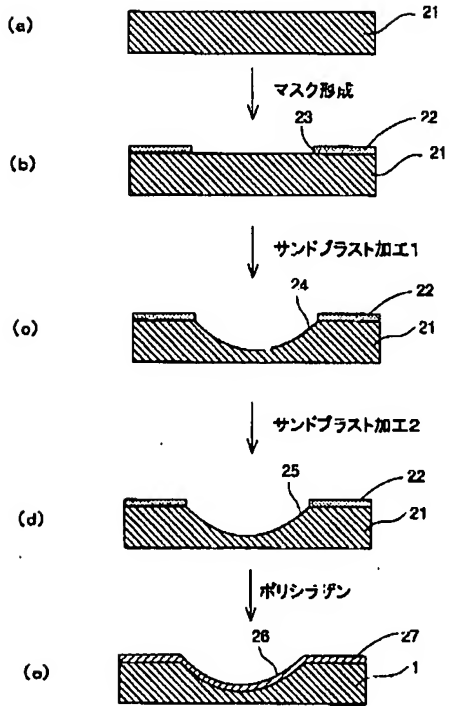

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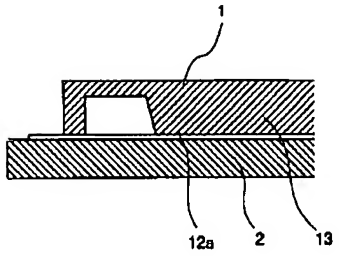

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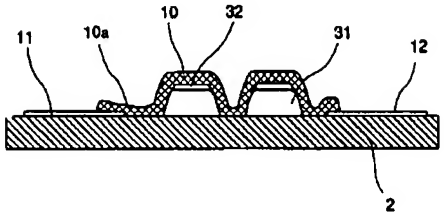

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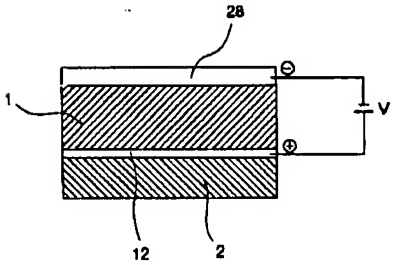

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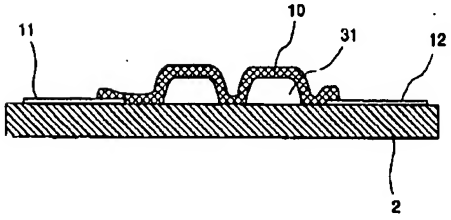

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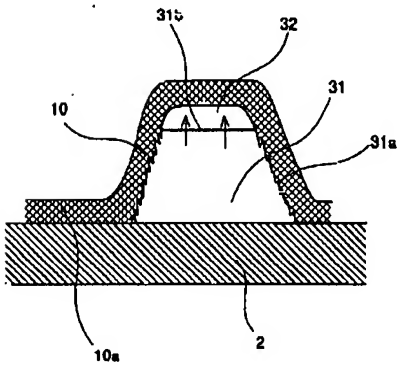

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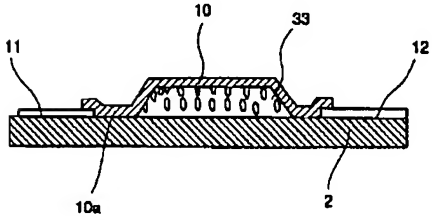

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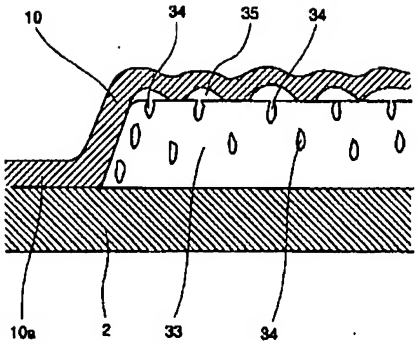

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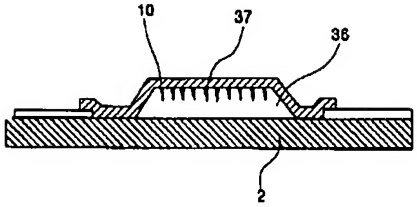

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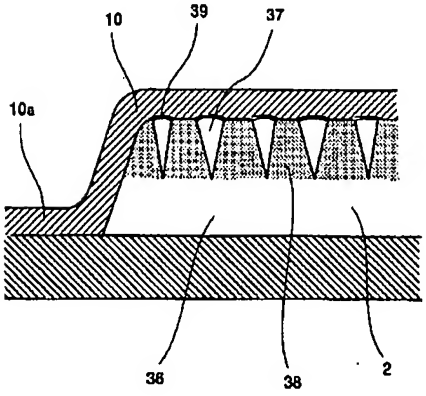

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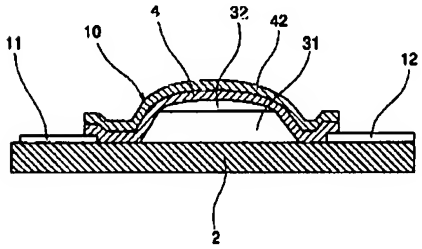

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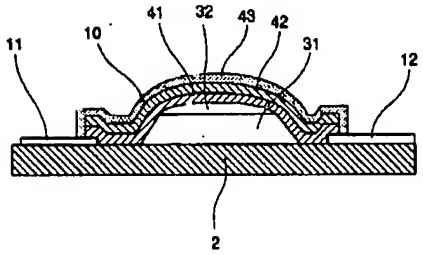

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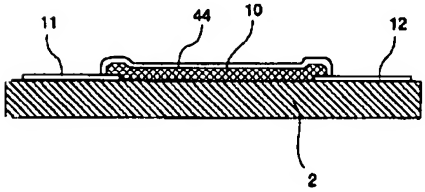

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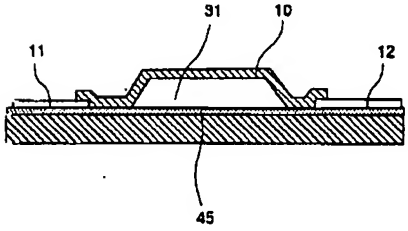

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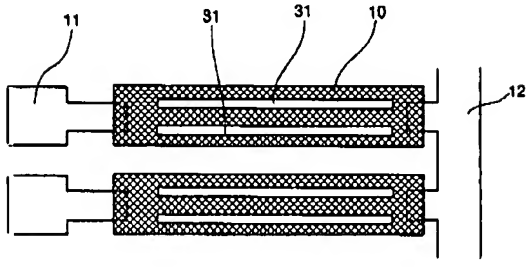

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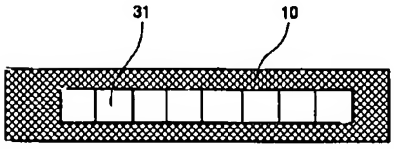

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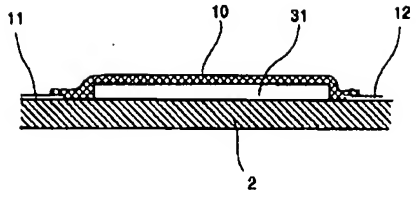

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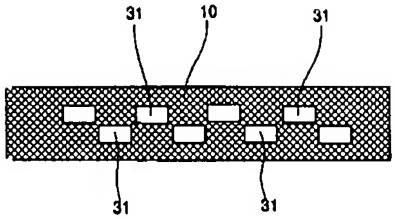

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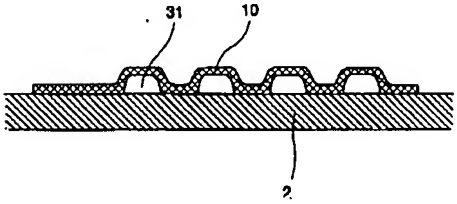

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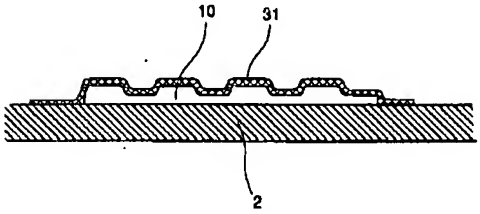

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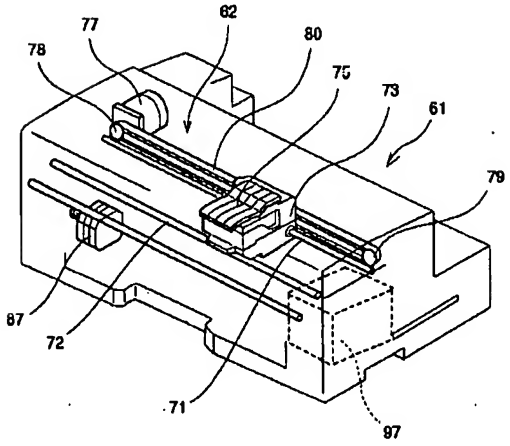

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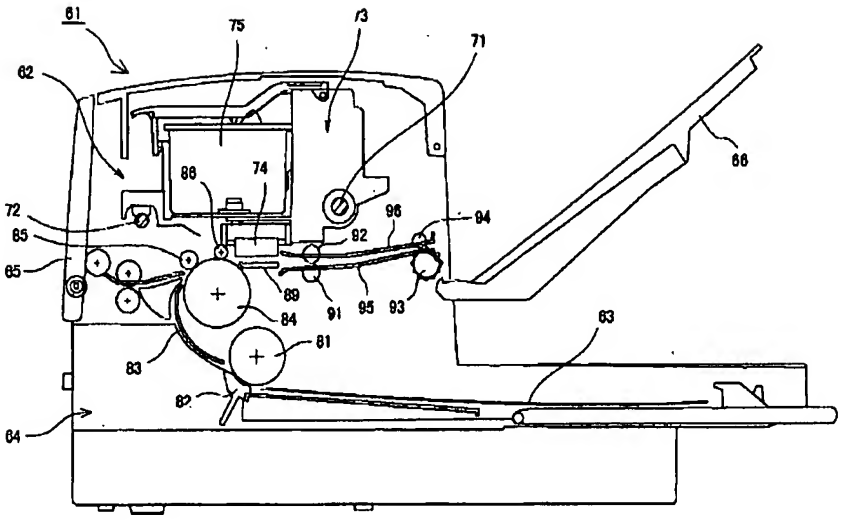

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the drop discharge head characterized by being the conductive ingredient with which thermal expansion of said actuator means is carried out by energization in the drop discharge head which the liquid of a liquid room is pressurized [discharge head] with an actuator means, and makes a drop breathe out, and the volume increases.
[Claim 2] The drop discharge head characterized by said conductive ingredient consisting of two or more layers from which coefficient of thermal expansion differs in a drop discharge head according to claim 1.
[Claim 3] Said conductive ingredient is a drop discharge head to which it is characterized by thickness being 1-20 micrometers in a drop discharge head according to claim 1 or 2.
[Claim 4] It is the drop discharge head characterized by said conductive ingredient being an ingredient within the limits whose coefficient of linear expansion is 2x10-E6-/degree-C - 50x10-E6-/degree C in claim 1 thru/or a drop discharge head given in 3.
[Claim 5] The drop discharge head characterized by the protective coat which has acidity or alkalinity-proof being formed by the liquid room side front face of said conductive ingredient in a drop discharge head according to claim 1 to 4.
[Claim 6] The drop discharge head characterized by having a internal structure object inside said conductive ingredient in a drop discharge head according to claim 1 to 5.
[Claim 7] The drop discharge head characterized by said internal structure object being thermosetting organic resin in a drop discharge head according to claim 6.
[Claim 8] The drop discharge head characterized by said internal structure object being an inorganic material in a drop discharge head according to claim 6.
[Claim 9] The drop discharge head characterized by said internal structure object being the metal membrane which has a metal oxide film in a drop discharge head according to claim 6.
[Claim 10] The drop discharge head characterized by having an opening between said conductive ingredients and said internal structure objects in a drop discharge head according to claim 6 to 9.
[Claim 11] It is the drop discharge head characterized by establishing said internal structure object by the pattern checkered, the shape of Rhine, and concave convex in a drop discharge head according to claim 6 to 10.
[Claim 12] It is the drop discharge head characterized by preparing said conductive ingredient in the substrate through an interference material layer in a drop discharge head according to claim 1 to 11.
[Claim 13] The drop discharge head characterized for having carried out anode plate junction of the substrate which prepared said conductive ingredient, and the passage substrate which forms said liquid room in the drop discharge head according to claim 1 to 12 by things.
[Claim 14] It is the thermal actuator characterized by being the conductive ingredient with which it is the thermal actuator which generates the actuator effectiveness by mechanical displacement, thermal expansion of this thermal actuator is carried out by energization, and the volume increases.
[Claim 15] The ink jet recording apparatus characterized by said ink jet head consisting of said drop

discharge head according to claim 1 to 13 in the ink jet recording apparatus which carried the ink jet head which carries out the regurgitation of the ink droplet.

[Translation done.]

* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the ink jet recording device which equipped with this drop discharge head the thermal actuator list which generates the drop discharge head which makes a drop discharge head and a thermal actuator list breathe out a drop by deformation by thermal expansion about an ink jet recording device, and the actuator effectiveness by mechanical displacement.
[0002]
[Description of the Prior Art] The nozzle to which the ink jet head which is a drop discharge head containing the micro-actuator generally used in the ink jet recording apparatus used as image recording equipments (image formation equipment), such as a printer, facsimile, a reproducing unit, and a plotter, carries out the regurgitation of the ink droplet, The liquid room which this nozzle opens for free passage (it is called a pressurized room, a pressure room, a pressurization liquid room, ink passage, a regurgitation room, etc.) It has a pressure generating means (actuator means) to pressurize the ink of this liquid interior of a room, liquid indoor ink is pressurized by driving an actuator means, and an ink droplet is made to breathe out from a nozzle.
[0003] The conventional ink jet head from the point of the class of actuator means The thing of a piezo mold which makes an ink droplet breathe out by carrying out the deformation variation rate of the diaphragm which forms the wall surface of a liquid room using a piezoelectric device, The thing of a bubble mold which generates a bubble in film boiling of ink using the exoergic resistor arranged in the liquid interior of a room, and makes an ink droplet breathe out, It is divided roughly into the thing of an electrostatic type which makes an ink droplet breathe out by carrying out the deformation variation rate of the diaphragm by electrostatic force using the diaphragm (or electrode of this and one) and counterelectrode which form the wall surface of a liquid room.
[0004]
[Problem(s) to be Solved by the Invention] If it is in a piezo mold among ink jet heads which were mentioned above, since a piezoelectric device does not contact ink directly but can also disregard generation of heat of a piezoelectric device, while there is an advantage that there is no constraint of the ink class to be used, when using high temperature processing (PZT baking) of a piezoelectric device, and a laminating mold piezoelectric device, mechanical and thermal technical technical problems, such as alignment of division and each piezoelectric device, are large, and cost becomes high with a complicated process and equipment.
[0005] Moreover, while it has the advantage that high integration of a head and a miniaturization are easy since a heater can be made very small by application of semiconductor technology if it is in a bubble mold, since heater skin temperature becomes high with 400-450 degrees C and extreme high temperature is given to ink in order to generate a bubble, an ink presentation changes, and the Kogation in the ink contact part of a heater occurs. Therefore, selection of an ink color becomes important, it is difficult to use pigment ink and a limitation is generated in high definition-ization of a color picture, and bubble generating becomes a defect by degradation of the heater by the Kogation, or it is [a heater

protective coat deteriorates for high temperature, and] easy to generate defects, such as a heater open circuit by the crack.
[0006] Furthermore, if it is in an electrostatic type, the process of micro processing is difficult like a piezo mold, there is little ingredient selectivity, and a process process is long and becomes cost quantity.

[0007] This invention is made in view of the above-mentioned point, and improves the degree of freedom of liquid selection, there is also no problem of a Kogation, and it aims at offering the thermal actuator suitable for a drop discharge head and this with easy small [reliable] and integration.
[0008]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the drop discharge head concerning this invention is taken as the configuration which is the conductive ingredient with which an actuator means carries out thermal expansion by energization, and the volume increases.
[0009] Here, it can consider as the configuration which a conductive ingredient becomes from two or more layers from which coefficient of thermal expansion differs. Moreover, as for a conductive ingredient, it is desirable that thickness is 1-20 micrometers. Furthermore, as for a conductive ingredient, it is desirable that it is an ingredient within the limits whose coefficient of linear expansion is 2x10-E6-/degree-C - 50x10-E6-/degree C. It is desirable that the protective coat which has acidity or alkalinity-proof is formed by the liquid room side front face of a conductive ingredient.
[0010] Furthermore, it is desirable to have a internal structure object inside a conductive ingredient. In this case, it is desirable that it is the metal membrane which has thermosetting organic resin, an inorganic material, or a metal oxide film as a internal structure object. Moreover, it is desirable to have an opening between a conductive ingredient and a internal structure object. This internal structure object can be established by the pattern checkered, the shape of Rhine, and concave convex.
[0011] A conductive ingredient can be prepared in a substrate through an interference material layer further again. Moreover, anode plate junction of the substrate which prepared the conductive ingredient, and the passage substrate which forms a liquid room can be carried out.
[0012] The thermal actuator concerning this invention is considered as the configuration which is the conductive ingredient with which thermal expansion is carried out by energization, and the volume increases.
[0013] The ink jet recording apparatus concerning this invention is considered as the configuration which the ink jet head which carries out the regurgitation of the ink droplet becomes from the drop discharge head concerning this invention.
[0014]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to an accompanying drawing. The important section typical sectional view of the ink jet head which is a drop discharge head which drawing 1 requires for the 1st operation gestalt of this invention, and drawing 2 are the strabism explanatory views of the 2nd substrate of this ink jet head.
[0015] This ink jet head forms the liquid room 6 which the nozzle 4 which comes to join the 1st substrate 1 which is a passage substrate, and the 2nd substrate 2, and carries out the regurgitation of the ink droplet, and a nozzle 4 open for free passage, and the common ink room 8 which supplies ink to the liquid room 6 through the fluid resistance section 7.
[0016] The crevice which forms the hole used as a nozzle 4, the liquid room 6, the fluid resistance section 7, and the common ink room 8 is formed in the 1st substrate 1. Although a hole and a crevice can be formed by etching etc., using a silicon substrate and a glass substrate as this 1st substrate 1, a ** glass substrate etc. can be used and the crevice which forms the hole which serves as a nozzle 4 with the sandblasting method of construction to a glass substrate, the liquid room 6, the fluid resistance section 7, and the common ink room 8 is formed here.
[0017] The actuator means which becomes the 2nd substrate 2 from the conductive ingredient 10 with which thermal expansion is carried out by energization, and the volume increases was established, and the common electrode 11 and the individual drive electrode 12 are connected to this conductive ingredient 10. As this 2nd substrate 2, although a silicon substrate (silicon wafer), a glass substrate, a

ceramic substrate, etc. can be used, the glass substrate is used here.
[0018] The thing of the monolayer to which the volume increases by the thermal expansion by energization as a conductive ingredient 10, or double lamination is used. For example, as a metallic material, aluminum, nickel-Co, nickel-Mn, Cu-nickel, Cu-Zn, duralumin, Cu-Sn, nickel, etc. can be used.
[0019] As for the thickness of this conductive ingredient 10, it is desirable to consider as within the limits of 1 micrometer - 20 micrometers, and it is within the limits of 5 micrometers - 10 micrometers more preferably. That is, in order to control the amount of ink droplets in the range of 2pl-35pl, for example, the outline ink volume is determined by the thickness of a conductive ingredient, and the size beside vertical x, but the thickness of the conductive ingredient 10 is a thin film in less than 1 micrometer, there is little bulk effect of the conductive ingredient 10, to a temperature up, since cubical expansion is not a ** rule, the amount of displacement of thickness cannot be small and the amount of ink droplets of 2pl cannot be secured. Moreover, it becomes [an energization current becomes large and / the gate width of the switching transistor for driving this head] large and is not practical, while the internal stress at the time of film growth becomes large, the conductive whole ingredient will exfoliate or deformation will occur, if thickness exceeds 20 micrometers. Especially, it becomes possible by carrying out thickness of the conductive ingredient 10 within the limits of 5 micrometers - 10 micrometers to drive with the relay switch IC of low cost.
[0020] Moreover, as for the coefficient of linear expansion of the conductive ingredient 10, it is desirable to consider as within the limits of 2x10-E6-/degree-C - 50x10-E6-/degree C. A thermal expansion according [the coefficient of linear expansion of the conductive ingredient 10] to energization is not enough, less than [2x10-E6/degree C], when desired expulsion of an ink droplet may not be obtained and coefficient of linear expansion exceeds 50x10-E6-/degree C (for example, thermistor), the amorphous part of a multiple oxide increases, by the temperature rise by energization, it is easy to produce recrystallization and reservation of dependability becomes difficult.
[0021] In the ink jet head constituted as mentioned above, since the conductive ingredient 10 carries out thermal expansion and the volume increases by impressing a drive wave between the common electrode 11 and the individual drive electrode 12, and energizing into the conductive ingredient 10, the content volume (volume)/pressure in the liquid room 6 change, and an ink droplet is breathed out from a nozzle 4. In this case, the temperature rise of the contact part of the ink in contact with the conductive ingredient 10 itself also has the synergistic effect to ink pressurization.
[0022] For example, as a conductive ingredient 10, if Cu (copper) (coefficient-of-linear-expansion 16.7x10E-6-/degree C) of 10-micrometer thickness is used, thermal-expansion volume increase of the ingredient by energization temperature (about 200 degrees C) rise is pressurizing the volume liquid ink of about 16 pl(s) by width-of-face [of 160 micrometers] x3000 micrometers long in an equivalent for 100dpi, and it is possible to make a minute ink droplet fly from each channel nozzle 4.
[0023] In this case, it is desirable to set up the fluid resistance of the fluid resistance section 7 and the configuration of a drive wave, and for the time constant of a temperature rise to rationalize, and to attain area of the conductive ingredient 10 and optimization of thickness and a temperature rise.
[0024] Thus, by having the actuator means which is the conductive ingredient 10 with which thermal expansion is carried out by energization, and the volume increases, liquid indoor ink is pressurized by the ink thermal expansion near the front face of thermal-expansion volume increase of an ingredient, and a conductive ingredient by energization temperature (about 200 degrees C) rise of a conductive ingredient, and a minute ink droplet is breathed out. In this case, there are few ink damages, the color-material selectivity for performing high-definition record, since an ink ingredient is not restricted to an organic inorganic material becomes large, and since a satellite drop is also small and distortion of the diameter of a pixel is small, the usual IC technique can be applied, further, high-definition record can be performed and it can manufacture [that production method of construction has a short process, and] it cheaply.
[0025] Here, since the coefficient of thermal expansion is carrying out abbreviation coincidence and contains movable ion in a glass substrate by using what formed the conductive ingredient 10 in the glass

substrate by IC method of construction as the 2nd substrate 2 using what formed passage (the liquid room 6, the fluid resistance section 7, common ink room 8, etc.) in the glass substrate by the sandblasting method of construction as the 1st substrate 1 especially, anode plate junction becomes easy and much more low cost-ization can be attained. Moreover, by performing junction which does not use adhesives etc., there is no flash of the adhesives of a between [adjacent channels], and there is no volume variation in each channel. The wettability of ink is still more uniform, there are no internal residual air bubbles in a liquid ink room, and, in each channel, ink flight becomes homogeneity.

[0026] Then, the passage formation by this sandblasting method of construction is briefly explained with reference to drawing 3 . First, a resist is applied or laminated in the glass substrate 21 used as the 1st substrate 1 as shown in this drawing (a), exposure and development are performed, and the mask 22 by the resist pattern for sandblasting which has the opening 23 according to the passage pattern of a nozzle 4, the liquid room 6, the fluid resistance section 7, and the common ink room 8 as shown in this drawing (b) is formed.

[0027] Subsequently, as shown in this drawing (c), after performing sandblasting processing using the big abrasive grain of the diameter of an abrasive grain and forming a crevice 24, the crevice 25 which performed sandblasting processing using the small abrasive grain of the diameter of an abrasive grain, and finished the wall surface of a crevice 24 as shown in this drawing (d) is formed.

[0028] although it can be processed even if the diameter of an abrasive grain uses a less than 3-micrometer abrasive grain when performing precision cutting by the sandblasting method of construction -- cutting Leto at this time (cutting speed) -- very much -- being small (0.5 micrometer/min extent) -- since a chipping becomes large when the diameter of an abrasive grain uses the abrasive grain exceeding 15 micrometers, it is unsuitable for high-speed precision cutting. On the other hand, the particle size of the abrasive grain to be used and the size of the chipping at the time of cutting are in an abbreviation correlation. Then, cutting speed (tact time) can be made quick by cutting about 80% of the purpose depth using the abrasive grain of a first big particle size (for example, 15 micrometers), and cutting to the purpose depth after that using the abrasive grain of a small particle size (for example, 3 micrometers), making magnitude of the chipping of a cutting side small.

[0029] Then, as shown in this drawing (e), the spin coat of the chipping and hair cracking by sandblasting is carried out by polysilazane, by carrying out thermal decomposition oxidation of this at 150-450 degrees C, the surface coat layer 27 of SiO2 is formed, and the crevice 26 used as the liquid room 6 which graduated the wall surface is formed. Here, the thickness of the surface coat layer 27 of SiO2 is 500-5000A, and is 1000-2000A preferably. By carrying out thermal decomposition oxidation, polysilazane becomes the film of the pure amorphous silicon O2, and its ink dependability (**** resistance) improves.

[0030] Moreover, when forming liquid room 6 grade in the 1st substrate 1 by the sandblasting method of construction, by using polysilazane as surface coat layers, such as a liquid interior wall side, the anode plate junction to the 2nd substrate 2 becomes easy, and direct solid-state junction is attained cheaply. That is, when the film of polysilazane is formed all over the 1st substrate 1, when surface smooth nature is good and carries out electrical-potential-difference impression at the time of anode plate junction, since there are few impurities, the processing film of polysilazane is high resistance, and a charge will concentrate it. The movable ion contained in the 1st substrate 1 moves to a junction interface with charge concentration by this, and it joins together by the ionic reaction (junction). the thickness of the range which reduction of the ion current by high resistance does not produce at this time -- it is preferably made 1000-2000A. Thereby, anode plate junction becomes easy.

[0031] In addition, as a mineral product in which smoothing of a sandblasting side contains fluoric acid 5 - 30wt%, by setting a chipping to 1 micrometer or less by this, hair cracking by sandblasting cutting is also removed and a vitrified front face can be secured [carry / it / by the chemical etching by the simple substance of a sulfuric acid, a phosphoric acid, a nitric acid, and an acetic acid, or two or more mixed acids]. Moreover, also by heating 300 degrees C of glass substrates, for example, and performing scanning annealing by carbon dioxide laser, annealing fusion of the nebula of a cutting part is carried out, melt of a chipping or the hair cracking is carried out, and they become the shape of translucent

glass.
[0032] Next, the 2nd operation gestalt of this invention is explained with reference to drawing 4 thru/or drawing 6 . In addition, it is the important section cross-section explanatory view in which the important section typical sectional view of the ink jet head which drawing 4 requires for this operation gestalt, and drawing 5 meet the important section flat-surface explanatory view of this head, and drawing 6 meets the A-A line of drawing 5 . This operation gestalt is an edge shooter method which has arranged the nozzle 4 to abbreviation parallel to the conductive ingredient 10 to the above-mentioned 1st operation gestalt being the side shooter method which has arranged the nozzle 4 in the location which counters to the conductive ingredient 10.
[0033] This ink jet head also forms the liquid room 6 which the nozzle 4 which comes to join the 1st substrate 1 which is a passage substrate, and the 2nd substrate 2, and carries out the regurgitation of the ink droplet, and a nozzle 4 open for free passage through the nozzle free passage way 5, and the common ink room 8 which supplies ink to the liquid room 6 through the fluid resistance section 7. And anode plate junction of this 1st substrate 1 and the 2nd substrate 2 which formed the conductive ingredient 10 is carried out. Moreover, some common electrodes 12 really form installation section 12a installed in the part corresponding to the septum 13 between each conductive ingredient 10 and 10 (i.e., between a liquid room) as shown in drawing 5 .
[0034] Here, this ink jet head is made into an example, and is explained also with reference to drawing 7 about the anode plate junction to the 1st substrate 1 and the 2nd substrate 2. As shown in this drawing, where the 1st substrate 1 is piled up on the 2nd substrate 2 The metal electrode 28 is arranged on the 1st substrate 1. Between an electrode 12 and the metal electrode 28 the condition for [300-600V, temperature / of 250-400 degrees C /, and time amount] 2 - 10 minutes Since Na2SiO3 separates into Na+ and SiO32- within the glass which is the 1st glass substrate 1 by impressing DC electrical potential difference and ionic bond (Si-O-nickel, Si-O-Cr) arises on electrode 12 front face, the 1st glass substrate 1 and the 2nd glass substrate 2 are joined.
[0035] Next, the 3rd operation gestalt of this invention is explained with reference to drawing 8 . In addition, this drawing is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt. This operation gestalt forms the internal structure object 31 in the interior of the conductive ingredient 10 by forming the internal structure object 31 on the 2nd substrate 2, and forming the conductive ingredients 10 including this internal structure object 32 front face. As a internal structure object 31, a thermosetting organic resin ingredient, for example, polyimide, a liquid crystal polymer, a bakelite, a polyamide, novolak system resin, etc. are used.
[0036] Thus, it is possible by forming the internal structure object 31 of a thermosetting organic resin ingredient in the interior of the conductive ingredient 10, and increasing the surface area and the volume of the conductive ingredient 10 to pressurize the ink of about 20 pl(s) according to thermal-expansion volume increase of the ingredient by the energization temperature (about 200 degrees C) rise of polyimide (coefficient-of-linear-expansion and 33x10E-6-/degree C) 5micrometer as for example, a heat-curing organic resin ingredient.
[0037] With this 3rd operation gestalt, since the expansion volume increases rather than the 1st operation gestalt, the range of the temperature rise by energization can become large, the modulation of an ink droplet is also possible, there are few ink damages, greatly [that high-definition color-material selectivity], small, distortion of the diameter of a pixel becomes small, and a satellite drop can also perform high-definition record more.
[0038] Next, the 4th operation gestalt of this invention is explained with reference to drawing 9 and drawing 10 . In addition, drawing 9 is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt, and drawing 10 is the important section expansion explanatory view of drawing 9 . Like the above-mentioned 3rd operation gestalt, the internal structure object 31 which consists of a thermosetting organic resin ingredient is formed on the 2nd substrate 2, the internal structure object 31 is formed in the interior of the conductive ingredient 10 by forming the conductive ingredients 10 including this internal structure object 31 front face, and this operation gestalt also forms an opening 32 between the conductive ingredient 10 and the internal structure object 31

further.
[0039] although, for example, as for a thermosetting organic resin ingredient, hardening progresses by the heat condensation polymerization reaction -- the case of polyimide resin -- a heat condensation polymerization reaction -- following -- H2 -- O and CO2 are generated -- making -- an ingredient solid-state -- about 40 wt(s)% -- it decreases. Polyimide resin is patternized in a proper configuration by HOTORISO, dry etching, etc., vacuum evaporationo and patternizing of the conductive ingredient 10 are performed after prebaking temperature processing of 250 degrees C, and the last heat-curing processing is carried out at 350 degrees C. At this time, by carrying out fitness control, the residual gas of a minute amount occurs, between [a part of] the conductive ingredient 10 and polyimide (internal structure object 31) exfoliates, and an opening 32 is formed.
[0040] As shown in drawing 10 , by in this case, the thing for which wall surface 31a of the internal structure object 31 is damaged The anchor effect over the conductive ingredient 10 is demonstrated, and it is hard coming to generate exfoliation of the conductive ingredient 10 in a wall surface 31a part. The conductive ingredient 10 can be made to exfoliate from the internal structure object 31 intentionally in the part which exfoliation of the conductive ingredient 10 becomes easy to produce by carrying out flat-surface smoothing of the top-face 31b of the internal structure object 31 on the other hand, and is easily made into the purpose. In addition, fixed part 10a with 2nd substrate 2 front face of the conductive ingredient 10 can acquire firm adhesion by plasma treatment.
[0041] Thus, by forming the internal structure object 31 which consists of a thermosetting organic resin ingredient in the interior of the conductive ingredient 10, and having the opening 32 where gas was enclosed between the internal structure objects 31 which become the interior of the conductive ingredient 10 from a thermosetting organic resin ingredient Since the thermal expansion of an organic resin ingredient (internal structure object 31) is multiplied by the thermal expansion of the conductive ingredient 10 and the thermal expansion of the very small gas in an opening 32 joins this by the temperature rise by energization Are efficient much more by pressurizing ink including the temperature up of liquid ink. Can make a minute ink droplet breathe out and control of the thermal-expansion volume of the ingredient by current control is attained. Gradation record by the dot system modulation can be performed, there are still few ink damages, the selectivity of high-definition color material becomes large, and since a satellite drop is also small and distortion of the diameter of a pixel is small, high-definition record can be performed.
[0042] Next, the 5th operation gestalt of this invention is explained with reference to drawing 11 and drawing 12 . In addition, drawing 11 is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt, and drawing 13 is the important section expansion explanatory view of drawing 12 . This operation gestalt forms the internal structure object 33 in the interior of the conductive ingredient 10 by forming the internal structure object 33 which consists of an inorganic material, and forming the conductive ingredients 10 including this internal structure object 33 front face on the 2nd substrate 2.
[0043] As this internal structure object 33, fine ceramics, such as heat ZrO2, SiO2, and TiO2, are used. These fine ceramics are that a degree of vacuum considers as the spatter film in a bad low vacuum, and serve as vacuum evaporationo film which has an opening 34 inside.
[0044] Of the opening 34 of this internal structure object 33, the conductive ingredient 10 exfoliates from internal structure object 33 front face partially, an opening 35 is formed between the internal structure object 33 and the conductive ingredient 10, and gas will be full in this opening 35.
[0045] Thus, by forming the internal structure object 33 which consists of ceramics in the interior of the conductive ingredient 10, and having the opening 35 where gas was enclosed between the internal structure objects 33 which become the interior of the conductive ingredient 10 from the ceramics Since the thermal expansion of the ceramics (internal structure object 33) is multiplied by the thermal expansion of the conductive ingredient 10 and the thermal expansion of the very small gas in an opening 35 joins this by the temperature rise by energization It can be efficient much more and a minute ink droplet can be made to breathe out by pressurizing ink including the temperature up of liquid ink. Moreover, in consideration of the relaxation and thermal conductivity of internal stress by thermal-

expansion deformation, waste heat is promoted and a high-speed drive is attained.
[0046] Next, the 6th operation gestalt of this invention is explained with reference to drawing 13 and drawing 14 . In addition, drawing 13 is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt, and drawing 14 is the important section expansion explanatory view of drawing 13 . This operation gestalt forms the internal structure object 36 in the interior of the conductive ingredient 10 by forming the internal structure object 36 which consists of a metal membrane which has a metal oxide film, and forming the conductive ingredients 10 including this internal structure object 33 front face on the 2nd substrate 2.
[0047] As a internal structure object 36, film, such as the metal membrane possessing a metal oxide film, for example, aluminum, Ti, etc., is used. Front faces, such as this metal, for example, aluminum, Ti, etc., are anodizing, and the porous metal oxidizing zone 38 which has pore 37 is formed in the interior.
[0048] Then, by forming the sealing film 39 with a thickness [by gamma-aluminum 2O3] of about 1 micrometer, closing the pore 37 of this internal structure object 36, and forming the conductive ingredient 10 on this, the opening which consists of pore 37 is formed between the internal structure object 35 and the conductive ingredient 10, and gas will be full in this pore 37.
[0049] Thus, by forming the internal structure object 36 which consists of a metal membrane which has the metal oxide film 38 in the interior of the conductive ingredient 10, and having the pore 37 which is the opening where gas was enclosed with the interior of the conductive ingredient 10 between metal membranes (internal structure object 36) Since the thermal expansion of a metal membrane (internal structure object 36) is multiplied by the thermal expansion of the conductive ingredient 10 and the thermal expansion of the very small gas in pore 37 joins this by the temperature rise by energization It can be efficient much more and a minute ink droplet can be made to breathe out by pressurizing ink including the temperature up of liquid ink. Moreover, in consideration of the relaxation and thermal conductivity of internal stress by thermal-expansion deformation, waste heat is promoted and a high-speed drive is attained.
[0050] Next, the 7th operation gestalt of this invention is explained with reference to drawing 15 . In addition, this drawing is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt. On the 2nd substrate 2, this operation gestalt formed the internal structure object 31 which consists of thermosetting organic resin, and has formed the conductive ingredients 10 of double layer structure (here two-layer structure) including this internal structure object 31 front face. The conductive ingredient 10 of this double layer structure forms platinum (Pt) and (line coefficient-of-thermal-expansion 8.7x10EE-6/degree C) by 2-micrometer thickness as a lower layer 41, and forms Nichrome (nickel-Cr) (number of line coefficients of thermal expansion 6x10E-6-/degree C) by 5 micrometers as an up layer 42 on this lower layer 41 front face. Between this conductive ingredient 10 and the internal structure object 31, the opening 32 where very small gas was contained is formed.
[0051] thus, since the bimetal effectiveness which resembles the up layer 42 side and carries out convex deformation according to the difference of the coefficient of thermal expansion of the lower layer 41 and the up layer 42 is demonstrated by the temperature rise according to energization by making the conductive ingredient 10 into double layer structure, the conductive ingredient 10 can make a minute ink droplet breathe out still more efficiently by it In addition, as a internal structure object 31, the internal structure objects 33 and 36 of each above-mentioned operation gestalt etc. can also be used.
[0052] Next, the 8th operation gestalt of this invention is explained with reference to drawing 16 . In addition, this drawing is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt. This operation gestalt forms the internal structure object 31 on the 2nd substrate 2, forms the conductive ingredients 10 of double layer structure (here two-layer structure) including this internal structure object 31 front face, and forms in conductive ingredient 10 front face (up layer 42 front face) further the protective layer 43 which has ink-proof nature.
[0053] Here, as a protective layer 43, organic film, such as polyimide film and aramid film, is used. Thus, since the amount of displacement of a bimetal ingredient will generate a crack greatly in the protective coat of an inorganic material when making the bimetal effectiveness produce using the

conductive ingredient 10 of double layer structure, the organic film is more desirable.
[0054] Thereby The conductive ingredient 10 can be protected from ink. That is, the corrosion of the conductive ingredient 10 can be prevented at ink by forming the protective layer 43 which has ink-proof nature, when an organic ion color, the pigment containing ion, and the conductive ingredient that does not have ink-proof nature since a dispersant and a surfactant are contained further become on a front face, and dependability can be secured over a long period of time.
[0055] Next, the 9th operation gestalt of this invention is explained with reference to drawing 17 . In addition, this drawing is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt. This operation gestalt forms the protective coat 44 which consists of an inorganic material with the ink-proof nature of the conductive ingredient 10 prepared on the 2nd substrate 2. As this protective coat 44, they are the inorganic-acid-ized film (SiO2, Si3N4, SiON, etc.), for example, inorganic oxides, CHITSU-ized film (TiN, BN, AlN, etc.), and carbide film (SiC, BC film, etc.).
[0056] When using the alloy which contains the ingredient with which coefficients of linear thermal expansion exceed 50x10-E6-/degree C, a thermistor ingredient, Mg with a big coefficient of thermal expansion, In, aluminum, K, Cu, Na, Pb, Li, etc. as a conductive ingredient 10, ink-proof is bad, and when especially the concentration of a pigment agent or a surfactant is high (2 - 3wt%), there is a possibility that the conductive ingredient 10 may be eluted. Then, by forming the protective coat 44 which consists of an inorganic material on conductive ingredient 10 front face, the conductive ingredient 10 can be protected from ink, the corrosion of the conductive ingredient 10 is prevented, and dependability can be secured over a long period of time.
[0057] Next, the 10th operation gestalt of this invention is explained with reference to drawing 18 . In addition, this drawing is an important section expansion explanatory view by the side of the 2nd substrate of this operation gestalt. This operation gestalt forms the internal structure object 31 and the conductive ingredient 10 through the interference material layer 45 on the 2nd substrate 2. Especially as an interference material layer 45, 10-50-micrometer frit glass is used as a glaze layer. It may replace with a glaze layer and SiO2 1-10-micrometer film, the amorphous membrane layer of SiON, etc. may be prepared.
[0058] Thus, while the internal stress by thermal-expansion deformation is eased by forming the interference material layer 45, the waste heat by thermal conductivity is promoted and a high-speed drive is attained, the adhesion of a conductive ingredient and a substrate improves, exfoliation can be prevented and dependability improves.
[0059] Next, the example from which the arrangement pattern of the internal structure object 31 (the same is said of the internal structure objects 33 and 36.) of the conductive ingredient 10 differs is explained with reference to drawing 19 thru/or drawing 24 . In addition, the flat-surface explanatory view in which drawing 19 explains the 1st example of this arrangement pattern, the cross-section explanatory view in which drawing 20 similarly explains the 1st example, the flat-surface explanatory view in which drawing 21 explains the 2nd example of this arrangement pattern, the cross-section explanatory view in which drawing 22 similarly explains the 2nd example, the flat-surface explanatory view in which drawing 23 explains the 3rd example of this arrangement pattern, and drawing 24 are cross-section explanatory views which similarly explain the 3rd example.
[0060] That is, the 1st example is an example which has arranged the internal structure object 31 on the 2nd substrate 2 in the shape of Rhine (condition that a slit is formed between the internal structure objects 31), the 2nd example is an example which has arranged the internal structure object 31 in checkers on the 2nd substrate 2, and the 3rd example is an example which has arranged the internal structure object 31 to concave convex on the 2nd substrate 2.
[0061] Thus, by choosing the arrangement pattern of the internal structure object 31, control and the partial avulsion from the internal structure object 31 of the volume increase by the thermal expansion of the conductive ingredient 10 by the temperature rise by energization are controllable. thereby -- expansion of the conductive ingredient 10 -- a variation rate -- the adhesion part of the positive displacement control of an amount and the substrate 2 in each channel and area can be determined, it

becomes quantum control of an ink droplet, and dependability improves. In addition, the configuration of a pattern is free in the range, if partial avulsion and fixed area can be rationalized.
[0062] Here, when using the internal structure object 31 of thermosetting organic resin, polyimide system resin has the ingredient of optical sensitivity, and it can perform easily patternizing in the purpose configuration by IC HOTORISO. Moreover, when using an ingredient without optical sensitivity, it can patternize easily by considering the dry cleaning dirty method of construction by IC HOTORISO similarly.
[0063] Moreover, in using the internal structure object 33 of inorganic ingredients (fine ceramics mentioned above), it is the membrane formation which has an opening 34 with the low-vacuum spatter vacuum deposition of the ceramics, and makes the precise SUPPATA film in a high vacuum. furthermore, the process of the internal structure object 36 of the metal membrane possessing a metal oxide film -- aluminum and Ti -- like -- anodic oxidation -- it is -- hole size ** of an opening, and a hole -- what can control the depth is desirable, sealing is possible for these ingredients and the thickness can also decide them with chemicals to be processing temperature and a time amount pan.
[0064] Next, the ink jet recording device concerning this invention is briefly explained with reference to drawing 25 and drawing 26 . In addition, drawing 25 is the outline strabism explanatory view of the device section of this recording device, and drawing 26 is the side-face explanatory view of this device section.
[0065] Carriage with this ink jet recording apparatus movable to a main scanning direction inside the body 61 of a recording apparatus, The recording head which consists of an ink jet head which is a drop discharge head concerning this invention carried in carriage, the printing mechanism section 62 grade which consists of ink cartridges which supply the ink to a recording head -- containing -- the lower part section of the body 61 of equipment -- from a front side -- many -- the sheet paper cassette (or a medium tray is sufficient.) which can load several sheets of forms 63 The detachable tray 65 for being able to equip with 64, enabling free extraction and insertion, and feeding paper to a form 63 by manual bypass can be ****(ed). After incorporating the form 63 with which it is fed from a sheet paper cassette 64 or a detachable tray 65 and recording a necessary image by the printing mechanism section 62, paper is delivered to the paper output tray 66 with which the rear-face side was equipped.
[0066] The printing mechanism section 62 holds carriage 73 for a main scanning direction by the main guide rod 71 and the ** guide rod 72 which were constructed horizontally across the side plate of the right and left which are not illustrated and which are a guide member, enabling free sliding. On this carriage 73, yellow (Y), cyanogen (C), a Magenta (M), Turn caudad the head 74 which consists of an ink jet head which is a drop discharge head concerning this invention which carries out the regurgitation of the ink droplet of each color of black (Bk), and it equips with the direction of expulsion of an ink droplet. The head 74 is equipped with each ink tank (ink cartridge) 75 for supplying the ink of each color exchangeable at the carriage 73 bottom. Ink is supplied in a head 74 through said ink supply hole from this ink cartridge 75.
[0067] Here, carriage 73 fits a back side (the form conveyance direction downstream) in the main guide rod 71 free [sliding], and is laying the front side (the form conveyance direction upstream) in the ** guide rod 72 free [sliding]. And in order to carry out the migration scan of this carriage 73 in a main scanning direction, a timing belt 80 is ****(ed) between the driving pulleys 78 and the follower pulleys 79 by which a rotation drive is carried out by the horizontal-scanning motor 77, and this timing belt 80 is fixed to carriage 83. Moreover, although the head 74 of each color is used as a recording head here, one head which has the nozzle which carries out the regurgitation of the ink droplet of each color is sufficient.
[0068] On the other hand, in order to convey the form 63 set to the sheet paper cassette 64 to the lower part side of a head 74 The feed roller 81 and the friction pad 82 which carry out separation **** of the form 63 from a sheet paper cassette 64, The tip koro 86 which specifies the send include angle of the form 63 from the guide member 83 to which it shows a form 63, the conveyance roller 84 which is reversed and conveys the form 63 to which paper was fed, and the conveyance koro 85 forced on the peripheral surface of this conveyance roller 84 and the conveyance roller 84 is formed. The rotation

drive of the conveyance roller 84 is carried out through a gear train by the vertical-scanning motor 87.
[0069] And the **** receptacle member 89 which is a form guide member to which it shows the form 63 sent out from the conveyance roller 84 corresponding to the successive range of the main scanning direction of carriage 73 by the lower part side of a recording head 74 is formed. In order to send out a form 63 in the delivery direction, the conveyance koro 91 and spur 92 by which a rotation drive is carried out are prepared in the form conveyance direction downstream of this **** receptacle member 89, and the delivery roller 93 and spur 94 which send out a form 63 to a paper output tray 66 further, and the guide members 95 and 96 which form a delivery path are arranged in it.
[0070] Moreover, to the migration direction right end side of carriage 73, the dependability maintenance recovery device (henceforth a "subsystem") 97 for maintaining the dependability of a head 74 and recovering is arranged. During printing standby, it is moved at this subsystem 97 side, and capping of the carriage 73 is carried out in a head 74 with a capping means etc.
[0071] In addition, in each above-mentioned operation gestalt, although the example applied to the ink jet head explained the drop discharge head and thermal actuator concerning this invention, it cannot restrict to this, and can apply also to the drop discharge head which carries out the regurgitation of drops other than ink, for example, the liquid resist for patterning, or can apply to a micro motor, the actuator section of a micropump, etc. as a thermal actuator.
[0072]
[Effect of the Invention] Since it considered as the configuration which is the conductive ingredient with which an actuator means carries out thermal expansion by energization, and the volume increases according to the drop discharge head concerning this invention as explained above, there are few damages with liquid, and the degree of freedom of selection of the charge of sap-wood (color material) improves, and small and integration are high easily unreliable, and low cost-ization can be attained further.
[0073] Here, by considering as the configuration which a conductive ingredient becomes from two or more layers from which coefficient of thermal expansion differs, volume change of a conductive ingredient becomes large and improvement in drop regurgitation effectiveness can be aimed at. Moreover, a conductive ingredient is considering as within the limits whose thickness's is 1-20 micrometers, and while a desired drop measure is securable, a low current drive is attained. Furthermore, a conductive ingredient is an ingredient within the limits whose coefficient of linear expansion is 2x10-E6-/degree-C - 50x10-E6-/degree C, and while a desired drop measure is securable, a low current drive is attained. Moreover, dependability is securable for the liquid room side front face of a conductive ingredient by forming the protective coat which has acidity or alkalinity-proof over a long period of time.
[0074] Furthermore, by having a internal structure object inside a conductive ingredient, thermal-expansion volume increase of a conductive ingredient and thermal-expansion volume increase of a internal structure object multiply, and the more efficient drop regurgitation becomes possible.
[0075] In this case, the thermal-expansion positive displacement control by current control becomes possible by using thermosetting organic resin as a internal structure object, and the diameter modulation of a dot becomes easy. Moreover, by using the metal membrane which has an inorganic material or a metal oxide film, thermal conductivity improves, accumulation is reduced and high-speed drive-ization can be attained. Moreover, by having an opening between a conductive ingredient and a internal structure object, expansion of the gas in an opening is also multiplied and the drop regurgitation can be performed much more efficiently.
[0076] By preparing by the pattern checkered, the shape of Rhine, and concave convex, quantum control of an ink droplet is attained, this internal structure object comes to be able to perform diameter control of a dot, and its dependability also improves.
[0077] By being prepared in a substrate through an interference material layer, the adhesion of a conductive ingredient of a conductive ingredient and a substrate improves, and its dependability improves further again. Moreover, low cost-ization can be attained by carrying out anode plate junction of the substrate which prepared the conductive ingredient, and the passage substrate which forms a

liquid room.
[0078] Since it considered as the configuration which is the conductive ingredient with which thermal expansion is carried out by energization, and the volume increases according to the thermal actuator concerning this invention, small and integration are high easily unreliable and low cost-ization can be attained further.
[0079] Low cost-ization can be attained, while the degree of freedom of selection of the charge of sap-wood (color material) improves and being able to attain high definition-ization, since the ink jet head which carries out the regurgitation of the ink droplet consists of a drop discharge head concerning this invention according to the ink jet recording apparatus concerning this invention.

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TECHNICAL FIELD

[Field of the Invention] Especially this invention relates to the ink jet recording device which equipped with this drop discharge head the thermal actuator list which generates the drop discharge head which makes a drop discharge head and a thermal actuator list breathe out a drop by deformation by thermal expansion about an ink jet recording device, and the actuator effectiveness by mechanical displacement.

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PRIOR ART

[Description of the Prior Art] The ink jet head which is a drop discharge head containing the micro-actuator generally used in the ink jet recording apparatus used as image recording equipments (image formation equipment), such as a printer, facsimile, a reproducing unit, and a plotter, is a pressure generating means to pressurize the nozzle which carries out the regurgitation of the ink droplet, the liquid room (called a pressurized room, a pressure room, a pressurization liquid room, ink passage, a regurgitation room, etc.) which this nozzle opens for free passage, and the ink of this liquid interior of a room.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since it considered as the configuration which is the conductive ingredient with which an actuator means carries out thermal expansion by energization, and the volume increases according to the drop discharge head concerning this invention as explained above, there are few damages with liquid, and the degree of freedom of selection of the charge of sap-wood (color material) improves, and small and integration are high easily unreliable, and low cost-ization can be attained further.
[0073] Here, by considering as the configuration which a conductive ingredient becomes from two or more layers from which coefficient of thermal expansion differs, volume change of a conductive ingredient becomes large and improvement in drop regurgitation effectiveness can be aimed at. Moreover, a conductive ingredient is considering as within the limits whose thickness's is 1-20 micrometers, and while a desired drop measure is securable, a low current drive is attained. Furthermore, a conductive ingredient is an ingredient within the limits whose coefficient of linear expansion is 2x10-E6-/degree-C - 50x10-E6-/degree C, and while a desired drop measure is securable, a low current drive is attained. Moreover, dependability is securable for the liquid room side front face of a conductive ingredient by forming the protective coat which has acidity or alkalinity-proof over a long period of time.
[0074] Furthermore, by having a internal structure object inside a conductive ingredient, thermal-expansion volume increase of a conductive ingredient and thermal-expansion volume increase of a internal structure object multiply, and the more efficient drop regurgitation becomes possible.
[0075] In this case, the thermal-expansion positive displacement control by current control becomes possible by using thermosetting organic resin as a internal structure object, and the diameter modulation of a dot becomes easy. Moreover, by using the metal membrane which has an inorganic material or a metal oxide film, thermal conductivity improves, accumulation is reduced and high-speed drive-ization can be attained. Moreover, by having an opening between a conductive ingredient and a internal structure object, expansion of the gas in an opening is also multiplied and the drop regurgitation can be performed much more efficiently.
[0076] By preparing by the pattern checkered, the shape of Rhine, and concave convex, quantum control of an ink droplet is attained, this internal structure object comes to be able to perform diameter control of a dot, and its dependability also improves.
[0077] By being prepared in a substrate through an interference material layer, the adhesion of a conductive ingredient of a conductive ingredient and a substrate improves, and its dependability improves further again. Moreover, low cost-ization can be attained by carrying out anode plate junction of the substrate which prepared the conductive ingredient, and the passage substrate which forms a liquid room.
[0078] Since it considered as the configuration which is the conductive ingredient with which thermal expansion is carried out by energization, and the volume increases according to the thermal actuator concerning this invention, small and integration are high easily unreliable and low cost-ization can be attained further.

[0079] Low cost-ization can be attained, while the degree of freedom of selection of the charge of sap-wood (color material) improves and being able to attain high definition-ization, since the ink jet head which carries out the regurgitation of the ink droplet consists of a drop discharge head concerning this invention according to the ink jet recording apparatus concerning this invention.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] If it is in a piezo mold among ink jet heads which were mentioned above, since a piezoelectric device does not contact ink directly but can also disregard generation of heat of a piezoelectric device, while there is an advantage that there is no constraint of the ink class to be used, when using high temperature processing (PZT baking) of a piezoelectric device, and a laminating mold piezoelectric device, mechanical and thermal technical technical problems, such as alignment of division and each piezoelectric device, are large, and cost becomes high with a complicated process and equipment.
[0005] Moreover, while it has the advantage that high integration of a head and a miniaturization are easy since a heater can be made very small by application of semiconductor technology if it is in a bubble mold, since heater skin temperature becomes high with 400-450 degrees C and extreme high temperature is given to ink in order to generate a bubble, an ink presentation changes, and the Kogation in the ink contact part of a heater occurs. Therefore, selection of an ink color becomes important, it is difficult to use pigment ink and a limitation is generated in high definition-ization of a color picture, and bubble generating becomes a defect by degradation of the heater by the Kogation, or it is [a heater protective coat deteriorates for high temperature, and] easy to generate defects, such as a heater open circuit by the crack.
[0006] Furthermore, if it is in an electrostatic type, the process of micro processing is difficult like a piezo mold, there is little ingredient selectivity, and a process process is long and becomes cost quantity.

[0007] This invention is made in view of the above-mentioned point, and improves the degree of freedom of liquid selection, there is also no problem of a Kogation, and it aims at offering the thermal actuator suitable for a drop discharge head and this with easy small [reliable] and integration.

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MEANS

(Actuator means) It has, liquid indoor ink is pressurized by driving an actuator means, and an ink droplet is made to breathe out from a nozzle.
[0003] The conventional ink jet head from the point of the class of actuator means The thing of a piezo mold which makes an ink droplet breathe out by carrying out the deformation variation rate of the diaphragm which forms the wall surface of a liquid room using a piezoelectric device, The thing of a bubble mold which generates a bubble in film boiling of ink using the exoergic resistor arranged in the liquid interior of a room, and makes an ink droplet breathe out, It is divided roughly into the thing of an electrostatic type which makes an ink droplet breathe out by carrying out the deformation variation rate of the diaphragm by electrostatic force using the diaphragm (or electrode of this and one) and counterelectrode which form the wall surface of a liquid room.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The important section typical sectional view of the ink jet head concerning the 1st operation gestalt of this invention
[Drawing 2] The strabism explanatory view of the 2nd substrate of this head
[Drawing 3] The explanatory view explaining an example of the production process of the 1st substrate of this head
[Drawing 4] The important section typical sectional view of the ink jet head concerning the 2nd operation gestalt of this invention
[Drawing 5] The important section flat-surface explanatory view of the 2nd substrate of this head
[Drawing 6] The important section cross-section explanatory view which meets the A-A line of drawing 5
[Drawing 7] The explanatory view with which explanation of the anode plate junction in this head is presented
[Drawing 8] The important section expansion explanatory view by the side of the 2nd substrate of the 3rd operation gestalt of this invention
[Drawing 9] The important section expansion explanatory view by the side of the 2nd substrate of the 4th operation gestalt of this invention
[Drawing 10] The important section expansion explanatory view of drawing 9
[Drawing 11] The important section expansion explanatory view by the side of the 2nd substrate of the 5th operation gestalt of this invention
[Drawing 12] The important section expansion explanatory view of drawing 11
[Drawing 13] The important section expansion explanatory view by the side of the 2nd substrate of the 6th operation gestalt of this invention
[Drawing 14] The important section expansion explanatory view of drawing 13
[Drawing 15] The important section expansion explanatory view by the side of the 2nd substrate of the 7th operation gestalt of this invention
[Drawing 16] The important section expansion explanatory view by the side of the 2nd substrate of the 8th operation gestalt of this invention
[Drawing 17] The important section expansion explanatory view by the side of the 2nd substrate of the 9th operation gestalt of this invention
[Drawing 18] The important section expansion explanatory view by the side of the 2nd substrate of the 10th operation gestalt of this invention
[Drawing 19] The flat-surface explanatory view explaining the 1st example of the arrangement pattern of the internal structure object in this invention
[Drawing 20] The cross-section explanatory view which similarly explains the 1st example
[Drawing 21] The flat-surface explanatory view explaining the 2nd example of the arrangement pattern of the internal structure object in this invention
[Drawing 22] The cross-section explanatory view which similarly explains the 2nd example [drawing

23] The flat-surface explanatory view explaining the 3rd example of the arrangement pattern of the internal structure object in this invention
[Drawing 24] The cross-section explanatory view which similarly explains the 3rd example
[Drawing 25] The outline strabism explanatory view of the device section showing an example of the ink jet recording device concerning this invention
[Drawing 26] The side-face explanatory view of this device section
[Description of Notations]
1 [-- The fluid resistance section, 8 / -- A common ink room, 10 / -- A conductive ingredient, 11 / -- An individual drive electrode, 12 / -- A common electrode, 31 33, 36 / -- 32 A internal structure object, 34 / -- An opening, 37 / -- Pore, 41 / -- A lower layer, 42 / -- 43 An up layer, 44 / -- A protective coat, 74 -- Head.] -- The 1st substrate, the 2 -- 2nd substrate, 4 -- A nozzle, 6 -- A liquid room, 7

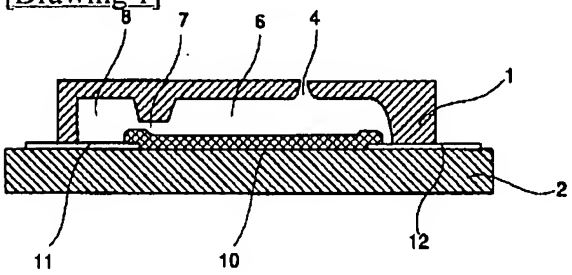
[Translation done.]

* NOTICES *

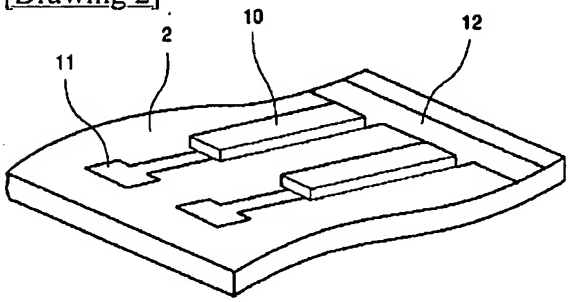
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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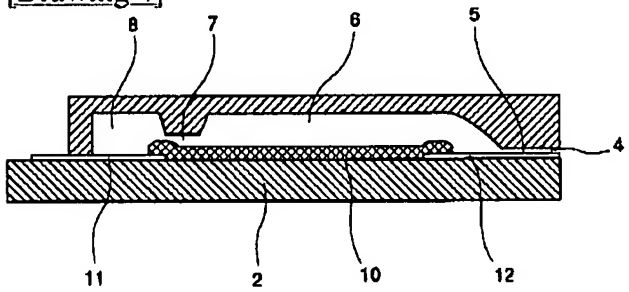
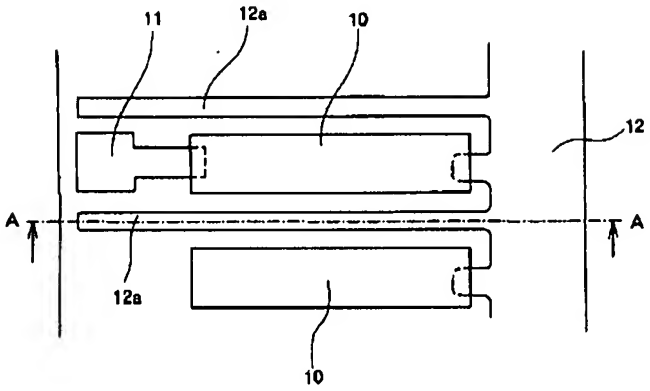


[Drawing 5]



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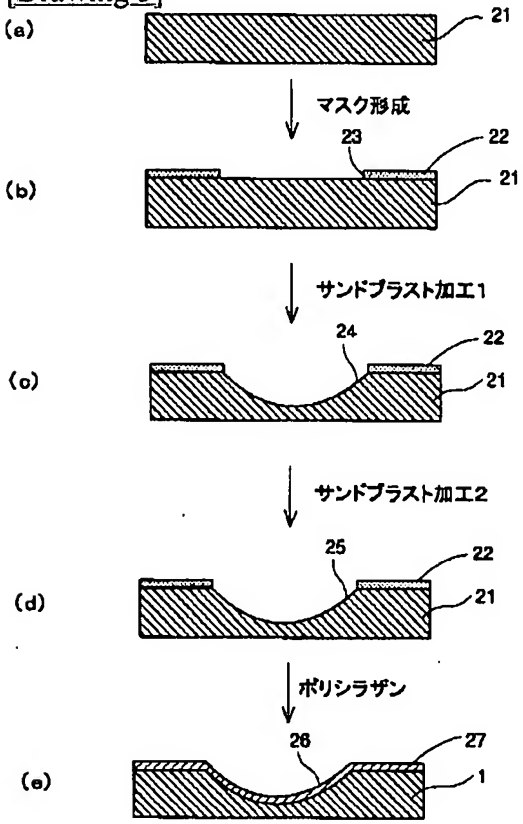

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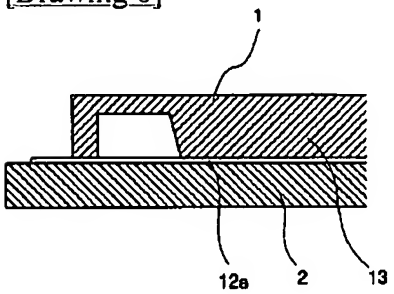

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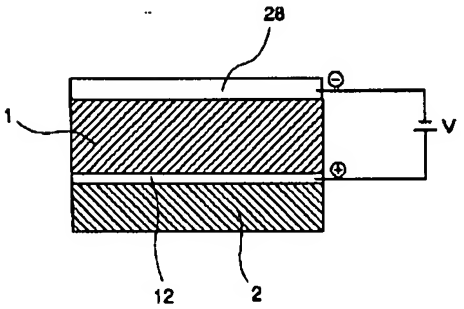

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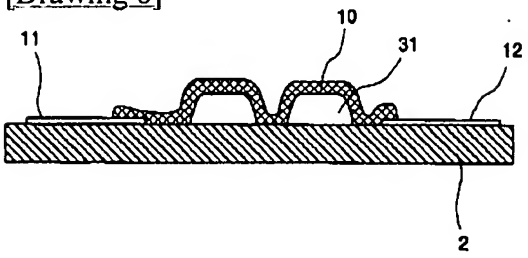

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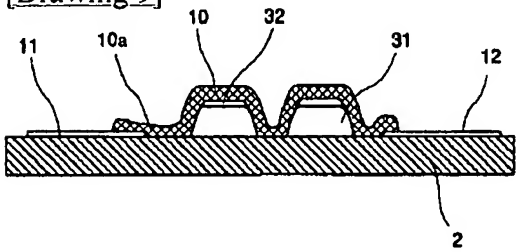

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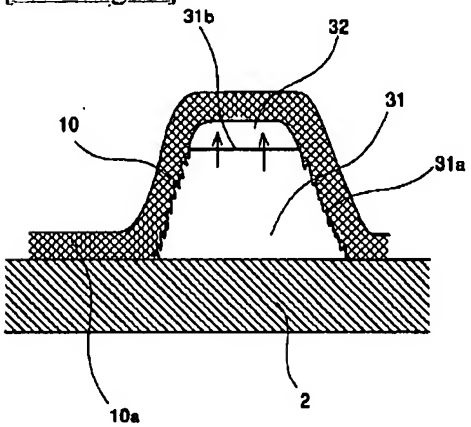

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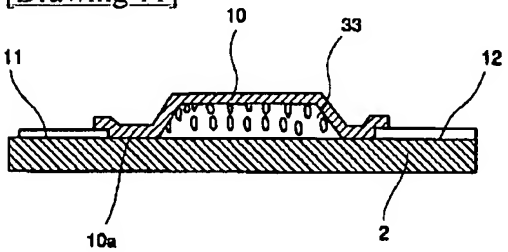

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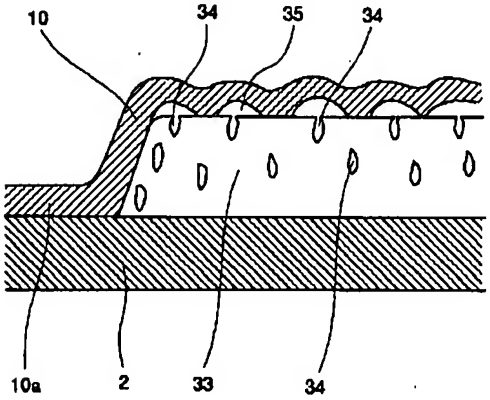

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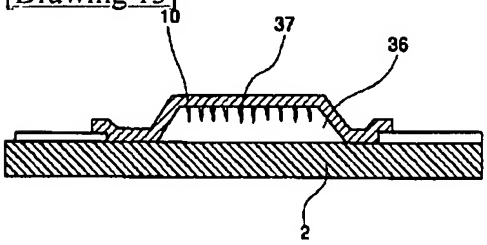

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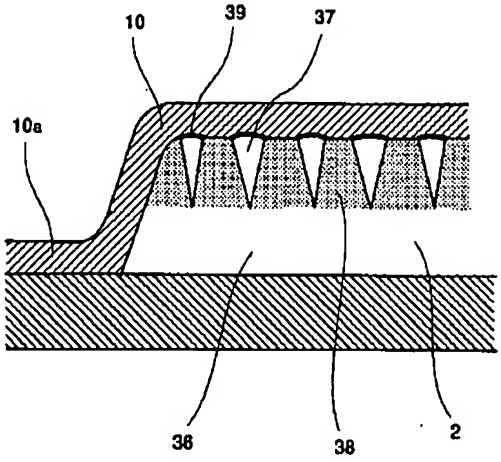

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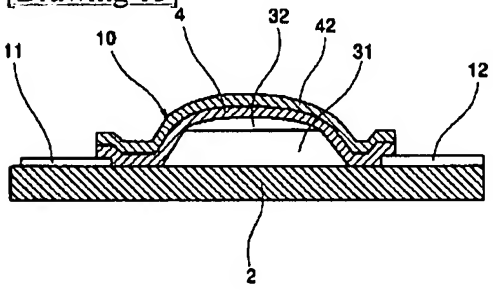

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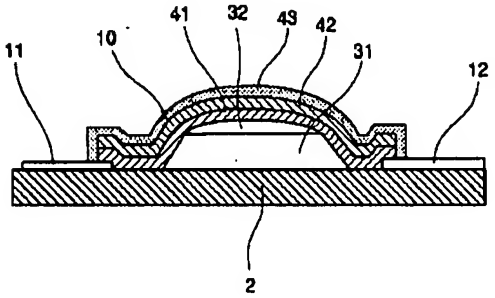

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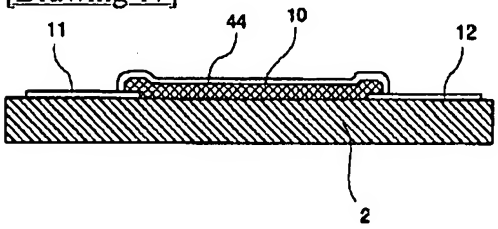

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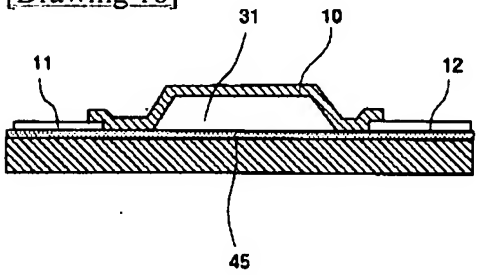

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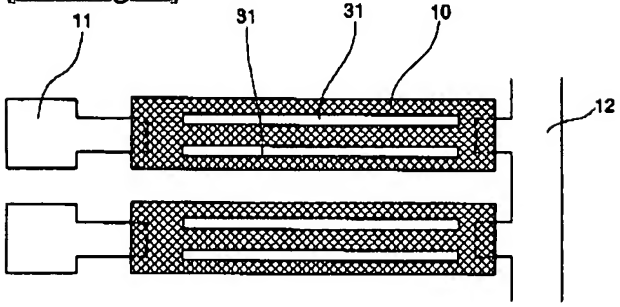

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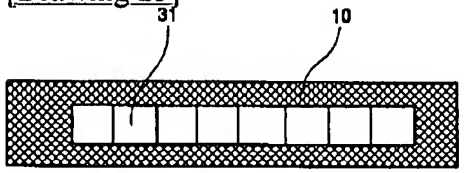

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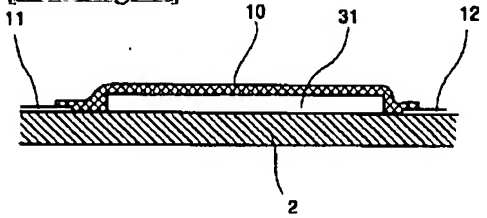

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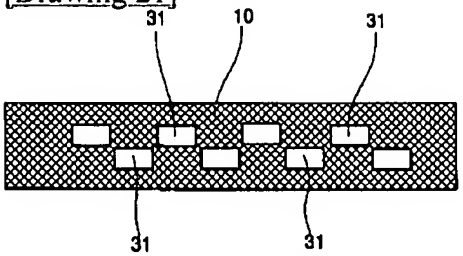

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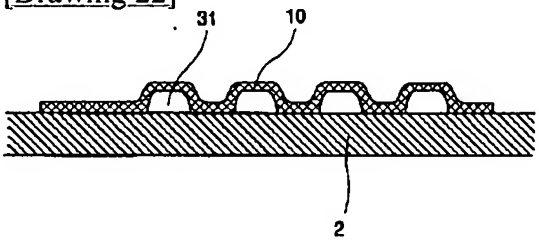

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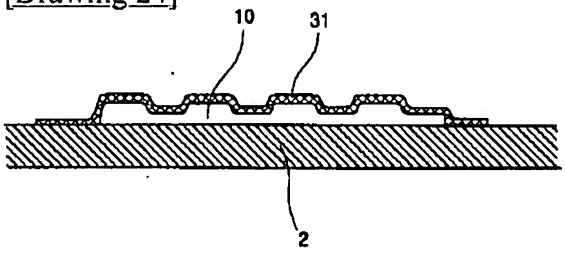

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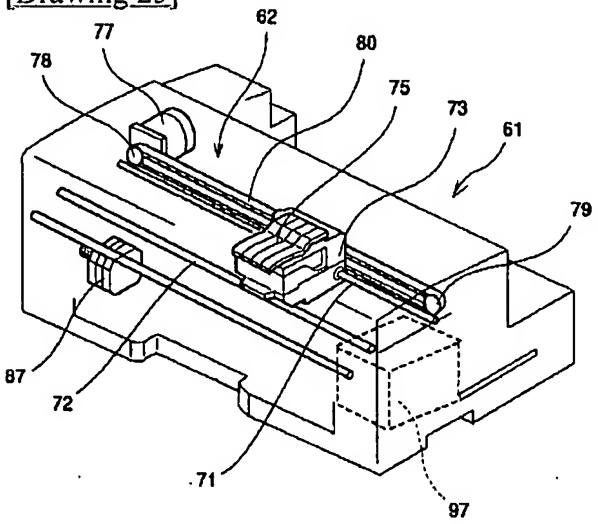
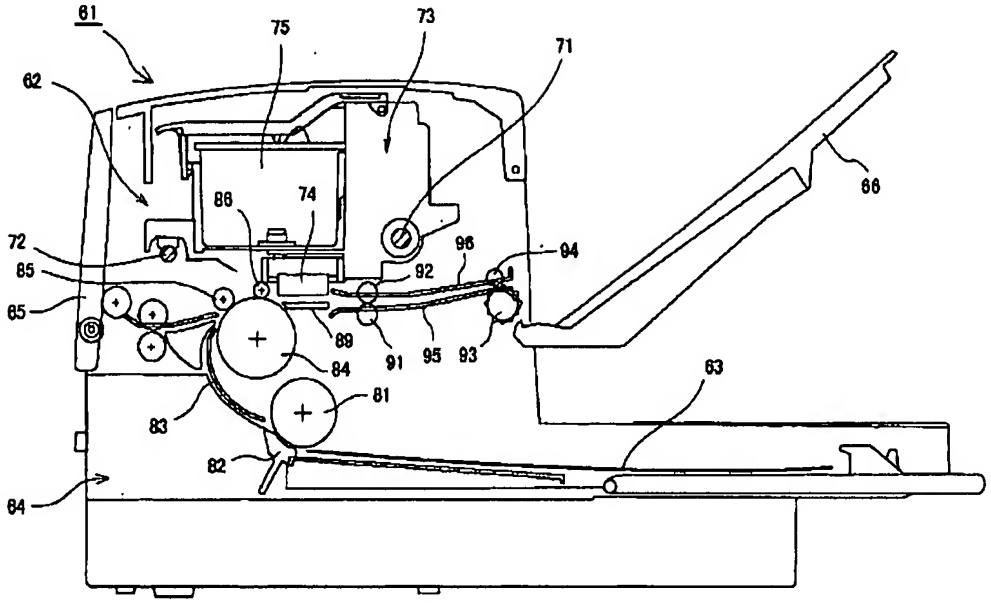


[Drawing 26]



[Translation done.]